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FLUMES FOR TRANSPORTING LOGS AND LUMBER.

We have published a large number of articles describing flumes for irrigation or water power purposes; but we find that very little has appeared in print on flumes for transporting ties, shingle bolts, and saw logs. A letter from Mr. Allan L. Weeks, of Walhalla, S. C., calling attention to the dearth of information on logging flumes follows:

The writer wishes to inquire from you, and through the columns of the News, from your readers, for information concerning the transportation of logs and lumber by flume over long distances. Have flumes for that purpose been built? And, if so, what has been the experience as to efficiency, cost of maintenance, wear and tear on product transported, etc? Any information concerning the above would be gratefully received.

Bearing upon the questions asked, we find, in our issue of Jan. 15, 1904, p. 45, a news note which we quote in full:

The longest flume in the world, at Madera, California, is finished. It is 53 miles long, and has in addition 18 miles of feeders. The flume is V-shaped, 46 ins. across the top and 36-in. sides. The cost was $270,000. It runs through the heart of the redwood forest, 185 miles from San Francisco, and will carry 400,000 ft. B. M. of logs daily when run to its full capacity.

In Bulletin No. 41, on "Seasoning of Timber," issued by the Bureau of Forestry, U. S. Dept. of Agriculture, some photographs are given of a 9-mile flume for transporting railroad ties. Of these photographs four are herewith reproduced, Figs. 1 to 4.

This flume has a grade of 200 ft. per mile, and it takes a tie 48 mins. to make the 9-mile trip.

We find no cost data nor designs of logging flumes in our previous issues, but the following articles on flumes built for other purposes contain valuable matter:

May 17, 1890, p. 463, a wooden irrigation conduit on an embankment.

Feb. 6, 1892, p. 120, an 18 × 32 ins. irrigation flume.

Oct. 1, 1896, p. 215, A trestle (45 ft. high) for carrying a flume to convey liquid lime.

Dec. 3, 1896, p. 354, A semi-circular wooden stave irrigation flume.

Feb. 25, 1897, p. 123, An irrigation flume lined with roofing felt.

Sept. 2, 1897, p. 150, A 5 × 8 ft. irrigation flume and a 61-ft. span timber arch built up of 1-in. boards.

Mar. 9, 1899, p. 144, A 5 × 5½-ft. power plant flume.

Mar. 23, 1899, p. 178, A 3½ × 18-ft. irrigation flume.

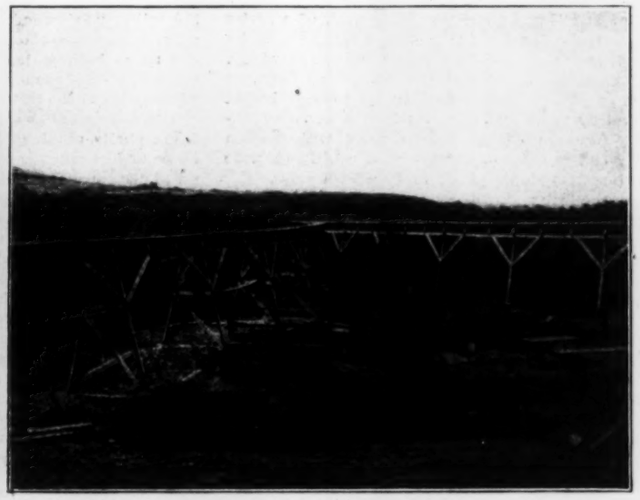
May 8, 1902, p. 374, Data on the construction of half round stave flumes given by the inventor of this type of flume.

Feb. 5, 1903, p. 133, Power-plant flume near Redlands, Cal.; traveling screen for catching twigs and leaves; also sand boxes.

Aug. 13, 1903, p. 151, A power-plant flume, (3 × 5 ft.) in Mexico.

In general we believe that for timber transportation the flume is chiefly advantageous where the grades or other conditions make a logging railway impracticable, and where only wood of moderate size is to be handled, such as cord-wood, ties, or boards. The cost increases very greatly if larger or longer pieces must be carried. Once built, if plenty of water is available along the route to make good the leakage and keep the flume filled all the time, the maintenance should not be excessive; but if used only a part of the year and allowed to dry out, the warping and shrinking of the boards makes maintenance very difficult and the structure is sure to be short-lived.

We shall be glad to hear from any of our readers who can give further particulars concerning the construction and use of such flumes.



FIGS. 1 AND 2. VIEWS OF A FLUME CARRIED ON TRESTLE WORK FOR TRANSPORTING RAILWAY TIES.

Fig. 3. Ties Ready for the Flume.

Fig. 4. The Flume in Winter.

A CONCRETE DAM ON A PILE FOUNDATION AT ST. JOHN'S LAKE, LONG ISLAND, NEW YORK.

Cold Spring Harbor lies between the towns of Oyster Bay and Huntington on the north shore of Long Island. St. John's Lake is an artificial lake of about 20 acres superficial area, with its level about 20 ft. above mean high water in the harbor. The lake gathers drainage water from a hilly, wooded area of 6.8 square miles. It is the third and last, as well as the largest, of a series of artificial lakes made in this drainage area by throwing earthen embankments across the valley.

The original earth dam at St. John's Lake, as far as known, was raised to its present height about 60 years ago. It contained a wooden spillway formed of planked crib work with wooden gates. The earthen embankment was 16 ft. wide on top with slopes of 1½ to 1 on both sides.

In the latter part of February, 1904, the wooden spillway of this dam with a small section of the earth dam on each side, was washed completely away by an exceedingly heavy flood caused by a heavy thaw with rains occurring at a time when the ground was covered with snow. The failure was probably caused by undermining on the harbor side, although it is not exactly clear how the accident occurred. The break in the dam was about 90 ft. wide at the bottom and about 150 ft. on top. Steps were immediately taken to replace the wooden crib dam with a permanent structure and designs were made calling for a concrete spillway with wing walls, all resting on wooden piles. The subsurface material at the dam site is gravel, hardpan underlying the gravel at depths varying from 6 to 10 ft.

An automatic spillway, that is, one without gates, could not be designed for the conditions required by the owners of the property, for it was required that the level of the lake should always be maintained under all conditions within 1 ft. of normal, in order that water might always be furnished to a flume a quarter of a mile distant from the concrete spillway, the water carried by this flume furnishing power for a grist mill. An automatic spillway would have required a width too great to permit of its being erected within the limits of cost assigned, as the flood volumes possibly passing over the crest might amount to 2,070 cu. ft. per second. A spillway 19 ft. 1 in. wide was therefore designed to carry off these flood waters, the regulation of the lake being governed by the wooden gates shown in Fig. 2. The apron of the spillway is a concrete sheet 3 ft. thick resting on piles and was placed at such an elevation that the mean high water of the harbor would just reach the toe of the apron. Exceedingly high tides advance up to the last rounded step at the dam.

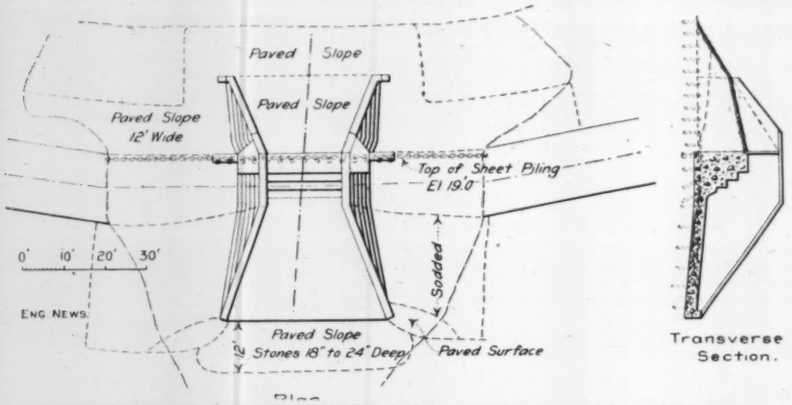


FIG. 1. GENERAL PLAN AND TRANSVERSE SECTION OF DAM AT ST. JOHN'S LAKE, L. I.

The concrete was a gravel concrete, the gravel being partly obtained from a neighboring gravel bank and partly from some gravel works a few miles distant and which was easily brought to the site by means of barges. All the sand was obtained from a neighboring sand bank and was not screened. This sand frequently contained large patches of gravel which required constant supervision in the manufacture of the concrete. This supervision was in the hands of the engineer's inspector, Mr. A. E. Budell, C. E., who changed the ratios of sand and gravel according to his judgment. The mixture used varied from 1 part cement, 4 parts of sand and 2 parts of gravel, to 1 part of cement, 3 parts of sand and 3 parts of gravel, no gravel larger than 2½ ins. being permitted. The concrete was mixed exceedingly wet and was tamped into place by light wooden rammers; in fact, the use of these rammers was not necessary as the material practically flowed into place. The forms were made of planed and matched boards thoroughly wetted down before the concrete was placed. Spades were inserted next to these forms in order to crowd the gravel back from the face, and upon final removal of the forms an entirely satisfactory face was obtained. The face was simply painted over with neat cement grout applied with a plasterer's brush. The cement was Nazareth, fulfilling the usual cement tests in an entirely satisfactory manner. The dam shows no signs of leakage, being entirely free from water stains, except at one point on the eastern wing wall, where a stream of water of the size of a knife blade, issued when water was first turned into the lake; this leak, however, is gradually closing and it is expected will be closed entirely by silting in of fine material.

The gates are of a simple pattern and much used in that part of Long Island. There are five sets of gates, each made in three sections, as shown in Fig. 2; the upper two sections are each provided with two handles and can be conveniently raised by one man. The lowest section which is a very heavy gate is raised by means of an 11 ft. lever formed of a 4-in. I-beam and the end of which fits into holes cut into the gate handle as shown in the figure. A fulcrum for the lever is provided by a wooden block on the bridge which spans the dam. Although the clear opening of the spillway is 19 ft., it is obstructed by the four posts supporting the gates. These are made of yellow locust, a timber exceedingly hard to work with and of exceeding long life in that neighborhood. The same timber was used in the spillway of the old dam, and after 60 years' use it showed no appreciable signs of decay. Timber posts and gates were used by the engineer in preference to iron ones because in his opinion its life would be fully as long, and it could be repaired or replaced more easily than the iron.

No endeavor was made to place the concrete dam on the hardpan subsoil; and no excavation was made at the site, except removal of surface silt, as excavating would have required sheet piling for retaining the side walls, and would have increased the cost of the work. The piles for the foundation were therefore driven through the 6 to 10 ft. of sand and gravel overlying the hardpan, and into the hardpan, as far as a 1,500-lb. hammer, falling between 15 and 20 ft., would drive them. The piles were of chestnut, with 6 to 8-in. tips, driven point downwards; the lengths of the driven piles varied from 12 to 15 ft. The piles were cut off at such an elevation that their heads remained imbedded in the concrete for a distance of 1 ft. The concrete dam, therefore, is carried almost entirely by the piles.

The following quantities of materials were used in the dam: 127 piles; 10,800 lin. ft. of sheet piling; 89 cu. yds. of concrete in the concrete apron; 85 cu. yds. of concrete in the dam itself; 318 cu. yds. of concrete in the wing walls; 37 cu. yds. of cobble in the cobble apron; 2,000 cu. yds. of earth fill. The gates and bridge were estimated to cost $200.

During the progress of the work the water was carried through the opening by means of a wooden flume lined with tar paper; it had a cross-section of 3 × 2 ft.

No particular trouble was experienced in guarding the work from freshets, a low earth dam being constructed back of the opening to lead the water into the temporary wooden flume. A core lining

FIG. 2. VIEW SHOWING DAM AND SPILLWAY, ST. JOHN'S LAKE, L. I.

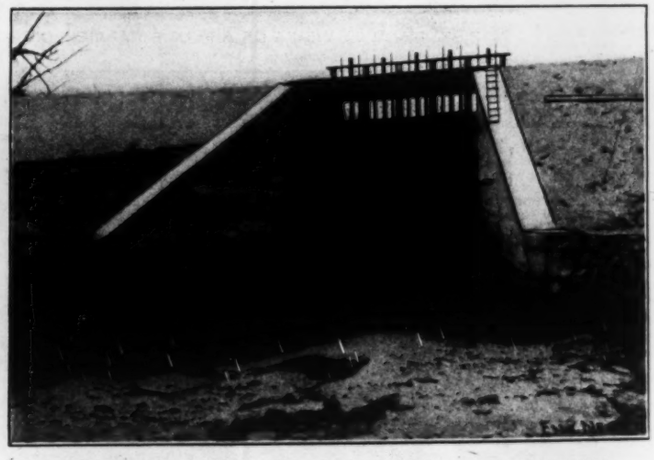


FIG. 3. VIEW SHOWING CONCRETE APRON AND SPILLWAY.

of 2-in. thickness of 2-in. pine plank was inserted in the new earth fill or dam in order to prevent percolation through it. Similar sheet piling was inserted under and along the back edge of the concrete dam in order to prevent water passing below and under the dam.

Work was fully completed except for the westerly section of the earth dam by Nov. 8, 1904, and the work of closing the opening was then commenced. The water in the lake rose only at the rate of ½-in. per hour, and caused no trouble in closing the final opening, the work being completed Dec. 3, 1904.

The contract price of the dam was $5,423, not including engineering or inspection, which brought the cost of the work to about $6,000. The contractors who performed their work in a faithful and efficient manner, were the Dean, Schwiers & Sutton Co., of 136 Liberty St., New York City. The owners are members of the Hewlett and Jones families of Cold Spring Harbor, Long Island. The Engineer was Dr. Myron S. Falk, of Columbia University.

A QUICKLY ERECTED REINFORCED CONCRETE DAM AT FENELON FALLS, ONT.

The dam here illustrated is interesting, not only as an example of the advanced method of construction in reinforced concrete, but as probably establishing the record for quick work. It forms one wing of a horse-shoe dam in the Fenelon River at the village of Fenelon Falls, Ont., joining a Government crib dam which is a part of the navigation system. It replaces a wood dam and creates a forebay delivering to the new power house of the municipal lighting plant and also serves the flour and grist mill of W. H. Meldrum & Co.

The dam stands on a smooth limestone ledge, the total length being 194 ft. The line of the dam is such that it takes in a pier of the highway bridge at about two-thirds of its length. Above the pier the average height is 9½ ft., this portion forming a spillway which also contains a sluice closed with stop logs (seen just above bridge) for releasing floating trash. Below the bridge the crest is 1 ft. higher, acting as a bulkhead and flood spillway.

The dam consists of triangular buttresses 12 ins. thick, 10 ft. c. to c., doweled to the ledge with steel pins, and supporting an inclined deck increasing from 7 ins. thick at the top to 10 ins. at the bottom, where it enlarges to a cut-off wall. The deck is reinforced with steel Thatcher bars ¾-in. and ⅞-in. in diameter, spaced from 6.3 to 7 ins. c. to c. Secondary reinforcing for hair cracks is provided for by fence wire. The deck shows a factor of safety of five under a 5-ft. flood, calculated by Thatcher's formula. The buttresses nowhere sustain a load greater than 4.5 tons per sq. ft.

The main current of the river falling over the Government dam runs parallel to the face of the new dam. It was therefore necessary to defend the buttresses against a jam of ice or logs which might otherwise pile up against them. This was done by means of a skirting of reinforced concrete 5 ft. high along the face of the buttresses, as shown in Fig. 1, which is the general cross-section of the roliway. The skirting is open underneath, so that the water rises equally on both sides, thereby equalizing the pressure.

Owing to the lighting requirements of the village, it was necessary that power be restored without the needless loss of a day. The contract was closed by telegraph on Sept. 28, 1904, under a time penalty for non-completion taking effect Nov. 1. The village undertook to supply crushed stone, sand and cement to the contractors. Thatcher bars were shipped from Pittsburg. The superintendent arrived on the ground Oct. 1 and

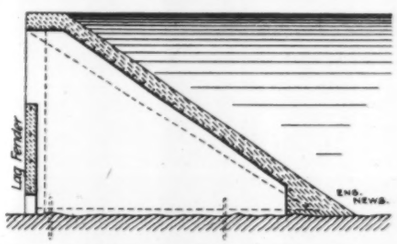


Fig. 1. Cross-Section of Reinforced Concrete Dam, Fenelon Falls, Ont.

the first man was set to work on the actual construction Thursday morning, Oct. 4.

Fig. 2 shows the state of the work, Oct. 18, at the end of the second week. This view is from the upstream side or back of the dam and shows the buttress forms filled, the cut-off wall started, and a part of the deck forms in place.

On Oct. 25, at the end of the third week, about half the deck had been laid. Oct. 26 was lost through failure of the quarrymen to supply stone and work was resumed on Oct. 27. The last concrete was laid at 4 p. m. on Nov. 1, thus completing the dam without forfeiture. Water to the depth of 3 ft. was at once admitted, the green concrete in the closing bay being protected from wash. The concrete was allowed to harden until Nov. 19, when it was found to be "bottle tight" and full head was admitted.

No night or Sunday work was done and allowing for one day lost for non-delivery of stone, the actual time of building a dam 194 ft. long and substantially 10 ft. high was 22 ordinary working days. By working a night crew this time could doubtless have been reduced to two weeks, but this was not considered practicable.

The dam was designed and built by the Ambursen Hydraulic Construction Co., of Boston, and the work was under the immediate charge of Mr. B. W. Flint as superintendent. The other contracting party was the Board of Water, Light & Power Commissioners of Fenelon Falls, Ont., D. Gould, Chairman, and F. A. McDiarmid, Secretary. For the information given we are indebted to Mr. W. L. Church, President and Consulting Engineer of the company named above.

THE CALUMET DRAINAGE CANAL.

The Chicago main drainage canal was built to effect the purification of Lake Michigan as the source of water supply of the city of Chicago, by diverting from the lake the flow of the Chicago River, which had become an immense open outfall sewer. The completion of this great work and the reversal of the flow of the river, however, still left two sources of pollution: (1) The sewers discharging along the lake shore, and (2) the Calumet River, which has also become a foul and dangerous stream by the discharge into it of sewage and refuse from industrial plants. Mr. Isham Randolph, Chief Engineer of the Sanitary District of Chicago, pointed out some time ago that the Calumet River, with its great volume of filth, enters the lake at a point only 3⅝ miles south of the outer intake of the Hyde Park water system, which supplies a population of over 525,000 (Eng. News, Sept. 10, 1903).

The first of these two sources of pollution will be eliminated by the system of intercepting sewers now in course of construction, which has been fully described in our issue of May 28, 1903. The second is to be eliminated by the construction of a drainage channel from the Calumet River to the Chicago main drainage canal. Different routes for such a channel have been proposed, but the Sag route was adopted by the engineering committee of the Sanitary District, as noted in our issue of May 5, 1904, and the general plans for this were adopted by the Sanitary District Trustees on Jan. 11, 1905.

This new channel, known as the Calumet-Sag channel, will extend from the Calumet River at Blue Island, to the main drainage canal at the small town of Sag, about 18 miles. The channel will be of the same general form as the main canal, but its bottom width will be probably only 90 ft., instead of 160 ft. The dimensions have not yet been determined upon, but it is probable that in rock the cross-section will be rectangular, with concrete walls from the natural rock surface to about 5 ft. above Chicago datum. In earth, the bottom width will be about 70 ft., with side slopes of 3 to 5, and a depth sufficient to give 22 ft. of water. The cost is estimated at about $12,000,000.

When this new canal is built the foul Calumet River will no longer flow east into the lake, but (like the Chicago River) its course will be reversed, and the water from the lake will flow west through the Calumet River and drainage channel and the Chicago drainage canal on its way towards the Mississippi River. The plans for this important auxiliary work have been prepared under the direction of Mr. Isham Randolph, M. Am. Soc. C. E., Chief Engineer of the Chicago Sanitary District, but he informs us that there is no likelihood of this work being put under contract within two years, as there is no money in sight to carry it on. The present Board of Trustees will probably purchase the right of way, which will exhaust the funds now available for this project.

FIG. 2. CONDITION OF WORK AT END OF SECOND WEEK, OCT. 18.

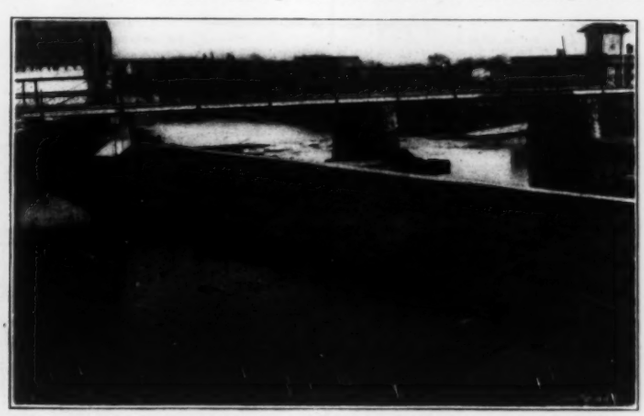


FIG. 3. COMPLETED DAM, NOV. 1.

VIEWS OF REINFORCED CONCRETE DAM, FENELON FALLS, ONT.

TYPES OF FILTER UNDERDRAINS, A NEW BALANCED VALVE AND A MODIFIED KOERTING EJECTOR SAND WASHER.

The following descriptive matter and accompanying illustrations have been selected from a paper on "Progress in the Filtration of Public Water Supply," by Charles Brossman, Jr., of Brossman & King, Indianapolis, Ind., read before the Indiana Engineering Society, Jan. 12, 1905.

Fig. 1 shows a number of types of collectors or underdrains which are explained by the sub-titles. Fig. 2 is a balanced inlet valve designed by Mr. Brossman for Algona, Ia., in which, he states, "the cost is reduced to a minimum."

In discussing sand washers the author describes

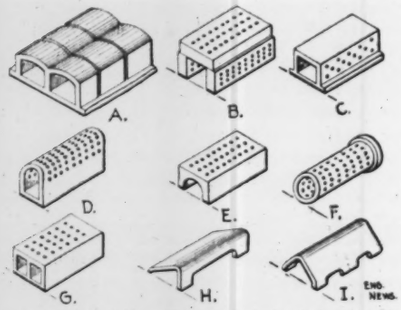


Fig. 1. Old and New Types of Underdrains for Slow Sand Water Filters.

A.—Lambeth water-works, London. Brick arches of about 5 ft. span, with open joints about every 2 ft.
B.—Southwark & Vauxall, London. Perforated brick.
C.—West Middlesex, London. Square tile with perforated sides.
D.—New River Works, London. Perforated.
E.—In a filter for paper mill in the United States.
F.—Perforated circular tile, Bideford, England, and Philadelphia, Pa.
G.—Perforated tile used at Indianapolis.
H.—Triangular tile designed for Algona.
I.—Triangular tile designed for Wilmington, Del.; modified form of it.

the one made abroad by Körting Brothers and his own modification thereof as follows:

This (the Körting.—Ed.) consists of several conical hoppers, at the bottom of each being a Körting ejector; the sand being placed in the first hopper and mixed with water. This is then conveyed by the ejector over a rectangular board with riffles and drops into the next hopper. The operation being repeated as many times as there are hoppers. The dirty water overflowing at the side of the hopper, and the sand finally being discharged well cleaned of its impurities. About 60 lbs. of water pressure is necessary at the ejectors. The volume of water used is about 14 times the sand volume.

A washer designed by the writer, Fig. 3, embodies the Körting ejector, but has half way up in each hopper an annular ring discharging a number of downward tangential jets into the sand. This produces a swirling motion to facilitate mixing the water and sand, which is then discharged through a Körting type of ejector above two circular riffle boards arranged one below the other. The sand and water flowing over these is dropped into the hopper below, where the operation is repeated. The distinguishing feature of this washer from the former type is in the swirling nozzles and the riffle board, the latter having 10 to 15 times the linear riffle surface over the older type.

THE ADJUSTED FIRE LOSSES ON THE FIREPROOF BUILDINGS AT BALTIMORE, MD.*

GENERAL COMMENT.—Supplementary to the publication of carefully prepared reports on the physical effects of the Baltimore conflagration, with especial reference to the so-called fireproof buildings, a brief summary and analysis of the insurance loss should be of interest. This record and analysis should prove of value for future guidance, inasmuch as an experience represented by figures showing the relative desirability of so-called fireproof buildings, as compared with other buildings, in a general conflagration, will, no doubt, appeal as something tangible. (See Table I.)

For use in this connection all possible information on losses has been obtained concerning buildings of all heights and types of construction, which to any considerable degree may be regarded as fireproof, either from their construction or loss ratio. In this last connection, it is noticeable that the building of poorest construction as a whole showed the smallest ratio of fire damage to value (31.9%) of any of the four-story or higher buildings here considered. This was the four-story building of the Commercial and Farmers' National Bank, the third and fourth floors and roof of which were of ordinary floor boards on wooden joists. The lower floors were of concrete arches and steel beams. This comparatively small fire loss may, in some degree, be explained by the fact that the building was well shielded, and the wooden construction, which was all destroyed, represented but a small part of the total value.

*Report of the Baltimore Committee of the National Board of Fire Underwriters.

There are 23 buildings on which data concerning the sound value, fire damage and insurance loss are tabulated for comparison. The total valuation of the 23 buildings was $6,546,040.02, on which the fire damage amounted to $3,684,062.26. The insurance amounted to $3,606,621.85, and the losses paid were $2,752,888.78.

The seven large buildings included in the 23 above referred to, on which the losses were adjusted by the Loss Committee on Fireproof Buildings, show a total valuation of $4,075,483, on which the fire damage amounted to $2,606,127, covered by $2,261,294 insurance, on which the losses paid amounted to $1,998,585.47.

The General Loss Committee, in their statement covering all the fire losses of the Baltimore conflagration reported to them, show a total valuation on all classes of property involved amounting to $37,382,426.49, covered by $32,245,273.39 insurance, on which the losses paid amount to $29,074,358.51. As all important losses are stated to have been reported to this Committee, the above figures can be assumed to represent a very large percentage of the total amount involved. Numerous small losses not reported to the Committee have been estimated at a little more than $1,000,000 additional. From the figures available we obtain the following ratio of insurance loss to total insurance:

Grand total of all classes of property involved, loss ratio, comprising both contents and buildings	90 %
The above, excluding the seven large buildings reported upon by the Committee on Fireproof Buildings	90.4%
The above seven large buildings reported upon by the Committee on Fireproof Buildings	88.4%
The above grand total, excluding the 23 so-called fireproof buildings on which we have the loss figures	92 %
The above 23 so-called fireproof buildings	76.3%

These figures show only a 2% smaller loss ratio on the seven large buildings reported on by the Committee on Fireproof Construction, when compared with all other classes of property, including both buildings and contents. This small advantage is practically negligible, and the experience gained from this conflagration, as shown by the loss figures and otherwise, justifies the conclusion that WHEN A CITY IS VISITED BY A GENERAL CONFLAGRATION, THE LARGE, HIGH, SO-CALLED FIREPROOF BUILDINGS, WITHOUT PROTECTION AT THE EXTERIOR WINDOWS, AND EXPOSED BY ORDINARY BUILDINGS, ARE BUT LITTLE BETTER FROM AN INSURANCE VIEW POINT THAN OTHER CLASSES OF PROPERTY.

It should also be remembered that in Baltimore none of the steel frames of the largest buildings collapsed or twisted to any great extent. Had this occurred the cost for wrecking would have more than overcome the value of the bricks, steel, etc., which materials resulted in some salvage with ordinary buildings. There were enough instances where the steel frames were distorted sufficiently to show that the possibility of a serious collapse must be reckoned with during such a conflagration, especially in buildings containing more combustible material than these office buildings at Baltimore.

The sound value, loss and damage on these seven large buildings were ascertained by appraisal, in order to present in detail, as far as possible, the effect of the fire on each part of the building; but the Loss Committee report having found unusual difficulties and delays in the proper adjustment of these losses, and from the experience and information in their possession, deem it wise to call attention to the fact that where a number of this type of buildings are involved at one time, as was the case here, owing to the limited number of builders engaged in this class of construction, a proper determination of the true measure of loss and damage can in various ways be blocked and proper adjustments avoided. Moreover, the cost for the services of experts is very great, this item alone being more than the premiums for five-year term policies.

The Committee in their report call especial attention to a few points brought out or emphasized by this fire:

(1) Well-burned brick and plain terra cotta are the only materials that stood the heat with any degree of success. Granite, marble and ornamental terra cotta and all kinds of building stone prove a failure when exposed to a fierce heat.

(2) Exposure charges on this class of buildings should be materially increased.

(3) A material extra charge should be made on buildings built of or faced with granite, marble or other building stone. The percentage of loss on these materials has been exceptionally heavy, and will be so from exposing fire, even in cases where the loss on a brick building would be nominal.

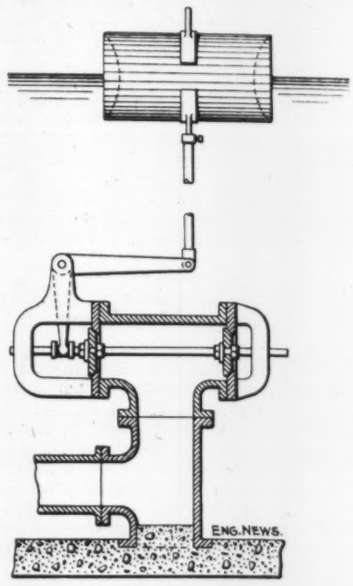


Fig. 2. Balanced Inlet Filter Valve Designed for Algona, Ia., Composed of Two Standard Tees and Accessories.

(4) The question of fireproofing is a serious one. This fire developed a great deal of shoddy work, some of the so-called fireproofing being practically useless, indicating that we have been too lenient in passing inferior materials and poor workmanship.

(5) The claims made, coupled with difficulties encountered in trying to reach a fair adjustment, and heavy expenses incident thereto, would seem to make it imperative that these elements should be considered in future in naming rates. This experience is not confined to Baltimore, having been encountered before, but has been strongly emphasized by events here.

Special attention is called to the analysis in Table I., showing what proportion the cost of each part of a building bears to its total cost. A careful consideration of this analysis will also show which parts of the buildings are most susceptible to damage by fire and the relative importance of this weakness as influenced by the proportion of the total cost represented by such parts. In this connection, note the high percentage of loss to value on such items as trim and finish, mason work and equipment, which includes electrical wiring, light fixtures, etc. The loss was relatively small on the steel frame and foundations, especially the latter, so often excluded. The loss on ornamental iron was materially less than for any other item under trim and finish.

Inasmuch as there was no uniform method of classifying the various parts for estimating the sound value, the table is not complete in regard to a few items. No estimate is given of cost of foundations for four buildings, and it is not clear where this amount is figured.

The majority of the policies were written with the

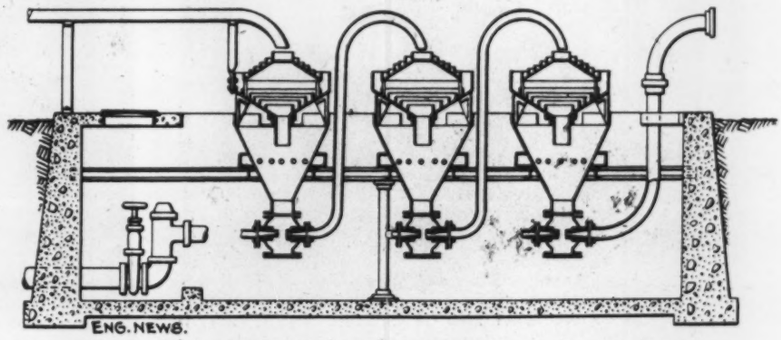


FIG. 3. MODIFIED FORM OF KOERTING EJECTOR SAND WASHER.
(Note the holes in the hoppers and the circular riffles above.)

co-insura[illegible]lause attached, but there were a number of policies w[illegible]ut any co-insurance feature.

No det[illegible] information on sound value, fire damage, etc., was [illegible]inable from several buildings, because there was eith[illegible] insurance or the amount was so small that the expe[illegible] of a detailed statement was not justifiable. Detailed [illegible]riptions of the physical effects of the fire on these [illegible]dings, with an approximate estimate of the fire loss, [illegible]e obtained from the reports of the National Fire Pro[illegible]n Association. (Copies may be obtained from the [illegible]etary, 67 East 21st St., Chicago.) The buildings here [illegible]ered to are as follows: Central Savings Bank Building, [illegible]y Court House, Safe Deposit & Trust Co.'s Building, [illegible]S. Custom House, U. S. Public Store House No. 1.

An approximate estimate of the annual premiums on the 23 buildings on which we have figures shows an income to the Insurance Companies of $5,363.50. The insurance loss on these buildings was $2,651,055.78.

So far as can be learned, there was but very little insurance on the rents of the so-called fireproof buildings. If there had been insurance on the rents of such buildings, total losses would in many cases have resulted, first, because of the delay in adjusting the building claims, and, second, because of the time it takes to reconstruct a building of this character.

In the detailed statements which follow for each building, the figures are taken from the report of the Committee on Losses on Fireproof Buildings for those buildings on which the Committee reported.

UNION TRUST BUILDING.—Detailed statement furnished by this company was as follows: Sound value, $434,581; loss, $354,381.10. Appraisal was entered into, the following being named: Walter T. Smith by assured, Samuel R. White by companies, Charles T. Wills, umpire; the umpire was not called. The award was: Sound value, $348,795; damage, $214,488; total insurance, $200,000; without co-insurance clause. The following are the details:

SUMMARIZED STATEMENT OF SOUND VALUE AND FIRE LOSS.

	Sound Value.	Salvage.	Fire Loss.
General expense	$6,500	$1,950	$4,550
Excavation and backfilling	4,350	4,350	.....
Foundations, footing and concrete	15,650	15,150	500
Granite belt course	2,500	.....	2,500
Stone ashlar	6,571	460	6,111
Brick work	36,017	24,537	11,480
Terra cotta	15,450	.....	15,450
Roofing	310	245	75
Sheet metal and skylight	2,222	522	1,700
Plastering	10,450	150	10,300
Floor arches	13,754	8,252	5,502
Wall lining	2,732	1,366	1,366
Partitions	5,565	1,113	4,452
Cinder concrete	2,037	400	1,637
Steel work	48,340	47,840	500
Ornamental iron	34,500	1,878	32,622
Marble	23,960	540	23,420
Mosaic	500	.....	500
Rough hardware	1,125	105	1,020
Finish hardware	2,625	15	2,610
Glass setting	5,126	.....	5,126
Rough carpentry	7,207	.....	7,207
Finish carpentry	18,765	150	18,615
Bank partitions	9,400	225	9,175
Fresco work	3,150	.....	3,150
Paint and varnish	7,100	40	7,060
Mail chute	1,695	35	1,660
Plumbing	11,590	420	11,170
Elevator plant	27,000	18,615	8,985
Generators and wiring	9 038	1,730	7,308
Fixtures	2,506	.....	2,506
Boiler plant, piping and heating	16,380	9,297	6,383
Scaffold	.....	.....	1,200
Cleaning up	.....	.....	2,800
Extra office partitions in rooms	1,800	.....	1,800
	$355,015	$139,385	$220,440
Deduct for junk			1,575
			$218,865
Depreciation	7,120		4,377
	$348,795		$214,488

I am herewith handing you appraiser's award, which shows a total loss as far as the insurance is concerned. I am also handing you an itemized statement, and in explanation will say that all the items were thoroughly gone over, as it was difficult to tell in the beginning what would be the result.

I will endeavor to point out all the weak points in this building, and show under like circumstances where much could have been saved with proper construction, as the heat was not so intense on this building as on some others. In the first place, the city ordered both sides of the building stripped; this was done before an appraisal was entered into. I am told by some good builders and terra cotta men that there was a good salvage in both stone and terra cotta, but as they were torn off and carted away, both these items were a total loss. The damage to brick work is such that it will require 32% to repair it. Roof, sheet metal and skylight, loss 70%; 50% of this was caused by the tearing off of the terra cotta cornices.

Fireproofing was hard tile, end construction. The arches suffered the greatest loss by the lower portion scaling off, and loss was 40%. The partition loss was 80%. This was not the fault of the tile as much as the poor construction and light walls, and the cutting into them to install pipes and wires. The wall lining was poorly put on, and sustained 50% loss. The columns were not properly covered, and the pipes run up alongside of them and the most of the fireproofing came off. Structural steel loss was only 1%. Ornamental iron, 95%. This was caused by the stairs being located in centre of building, with large well-hole and open areaway from top to bottom, and they all melted down. Elevator plant loss 33⅓%. Boiler and heating plant, 37%. Electric light plant, 80%. This was caused largely by the pipe and wire shaft not being cut off, as no damage was done in the basement, except by the fire that came down this shaft. The bank fittings and fixtures and wood partitions in this building were quite an item, and were a total loss.

In submitting to you this statement, I have stated things as I found them, and can furnish other details, if desired.

(Signed) Samuel R. White.

THE CALVERT BUILDING.—No details of sound value and loss presented. Assured claim total loss on insurance, cheerfully assenting to appraisal. The adjustment resulted as follows: Sound value, $634,075; damage, $363,256. Appraiser named by assured, O. G. Selden; by companies, Samuel R. White; umpire, Charles T. Wills; umpire not called. The total insurance was $150,000, without co-insurance. Following are details of award:

SUMMARIZED STATEMENT OF FIRE LOSS ON CALVERT BUILDING.

	Value.	Salvage.	Repairs.
General conditions	$12,170	$5,570	$6,600
Excavation and backfilling	7,920	7,920	.....
Concrete foundations and granolithic floors	4,705	4,705	.....
Sidewalks and curbs	825	742	83
Shoring banks and holding adjoining property	990	990	.....
Rubble stone and granite pier caps	4,142	4,142	.....
Common brick	41,757	39,432	2,325
Face brick	11,561	5,945	5,616
Special staging, shoring and wrecking	.....	.....	1,578
Enameled brick	5,434	5,047	387
Cleaning and pointing	1,320	450	870
Removing debris from building (resulting from fire)	.....	.....	4,377
Sand blast exterior walls	.....	.....	3,391
Building sidewalk protections	.....	.....	1,650
Fireproofing—Arches	30,029	27,785	2,244
Partitions	11,919	1,220	10,699
Cinder fill	3,660	1,220	2,440
Wrecking and cleaning partition tiles	.....	.....	1,170
Cut stone and granite	26,779	14,067	12,712
Cutting out and preparing for restoration	.....	.....	3,000
Plastering	19,369	500	18,869
Cleaning and washing walls and ceilings	.....	.....	1,235
Terra cotta	48,241	12,741	35,500
Rough carpentering	16,386	300	16,086
Finished carpentering	27,361	1,800	25,561
Rough hardware	1,820	500	1,320
Finished hardware	5.607	100	5,507
Sheet metal and roofing, including glazing of skylights and sheathing of bridge	7,757	4,625	3,132
Marble	45,105	1,100	44,005
Glass	5,734	50	6,684
Paint	8,498	.....	8,498
Ornamental iron and marble stair treads	37,181	23,398	13,783
Structural steel and iron—Material	74,815	74,440	375
Erection	10,780	10,050	730
Shop drawings	3,080	2,970	110
Painting	1,540	1,540	.....
Teaming	2,035	2,035	.....
Mail chute	1,721	1,061	660
Plumbing	22,500	2,500	20,000
Heating	44,500	4,000	40,500
Electric wiring	32,000	500	31,500
Electric fixtures	3,079	.....	3,079
Elevators	48,700	18,700	30,000
Filter plant	2,785	2,535	250
Coal scales	270	70	200
Totals	$634,075	$284,750	$365,756
Deduct salable junk			2,500
Total loss			$363,256

I am herewith handing you award signed by both appraisers, also summarized statement showing the manner in which we arrived at the award. In explanation of this statement, will say that the first item is intended to cover all legitimate expenses in the way of superintendent, insurance, permits, etc., and all other items carry with them a reasonable builder's profits, consequently you will not find the 10% added at the end. The items on this building for scaffolding, shoring up, taking out damaged material and cleaning up are necessarily large, on account of the nature of the loss, as parts of the building that were not damaged have to be removed to replace other parts that were destroyed.

In making this report I will state some points in construction showing (as I see it) their weak points: The structural steel in this building suffered about 1 1-3%; ornamental iron about 37%; common brick 5½%; enameled brick 7%; face brick nearly 50%, largely caused by being compelled to remove them to replace damaged terra cotta; the terra cotta was damaged about 74%. The fireproofing in this building was largely of hollow tile. The arches were of end construction and stood well, with a loss of 7 1-3%. The partitions, as you will see, were nearly a total loss, as the wrecking and clearing up nearly equals the salvage. This loss cannot be charged entirely to the fire-proofing material, but was caused by the manner of construction and the weakening of the thin partitions in installing the electrical and mechanical devices. The contractors should install this work as the partitions are being set, and not cut into them afterwards. Again, these partitions were not sufficient in thickness to withstand the strain after the plastering dropped off. In some instances in this building wood strips had been laid into the wall for furrowing and a rough frame of 2 × 4 around door openings, which should not be allowed. The interior of the outside walls in this building was faced with common brick, and no loss occurred. The column coverings were poorly constructed in many places, caused largely by the different pipes of the mechanical plant running beside them. These columns should be well and independently fireproofed, as on their preservation depends largely the whole structure. The posts and girders in this building between ceiling and roof were not fireproofed. In this particular instance, this did not cause any additional damage, as the expanded metal lath and plaster hanging ceiling stood the test, but had this ceiling given away the roof would have been wrecked. All shafts for use of pipes, wires, etc., should be cut off around same at each story and be made as near fireproof as possible. Large well-holes and poorly constructed open stairs in centre of building are hazardous, to say the least, and could be arranged differently without detriment to the building. These defects were not so noticeable in this particular building, but were very noticeable in some others, and had they been remedied the companies would have received a salvage instead of paying a total loss.

(Signed) Samuel R. White.

HERALD BUILDING.—No details of sound value and loss presented. Appraisal was agreed to, but assured first took position that the companies' appraiser must be a man from immediate vicinity, and after receding from that position insisted that umpire must be a local man. This action caused considerable delay, but appraisal was finally completed with the following results: Sound value, $217,131; loss, $127,605. Appraiser named by assured, J. Henry Miller, of Baltimore; by companies, H. M. Leighton, of Minneapolis; umpire, William Griffith, of Cincinnati. Total insurance, $125,000, all with 80% co-insurance clause. Companies pay $91,826.04; assured contributing $35,778.96; total, $127,605. Award signed by both appraisers and umpire and details follow.

SUMMARIZED STATEMENT OF SOUND VALUE AND FIRE LOSS OF HERALD BUILDING.

	Sound value.	Salvage.	Fire loss.
Excavation and backfilling	$4,500.00	$4,500.00	.....
Foundations, footing, etc.	10,850.00	10,440.00	$410.00
Stone ashlar	20,270.00	12,100.00	8,170.00
Common brick	24,350.00	17,350.00	7,000.00
Pressed brick	2,729.40	.....	2,729.40
Terra cotta (salvage offsets setting)	11,000.00	.....	11,000.00
Roofing	837.32	.....	837.32
Sheet metal and skylights	2,496.10	160.16	2,335.94
Plastering	6,436.40	.....	6,436.40
Floor arches	7,978.50	3,989.25	3,989.25
Partitions	2,898.00	.....	2,898.00
Concrete fill over arches	1,058.22	.....	1,058.22
Steel work	42,389.26	29,389.26	13,000.00
Ornamental iron	10,025.00	6,407.83	3,617.17
Marble	3,077.30	.....	3,077.30
Tile mosaic	4,325.00	100.00	4,225.00
Rough hardware	485.00	.....	485.00
Finish hardware	1,115.00	.....	1,115.00
Glass and setting	2,450.00	.....	2,450.00
Rough carpentry	3,682.00	.....	3,682.00
Finish carpentry	11,080.00	.....	11,080.00
Office grill	423.00	.....	423.00
Painting, varnish and fresco	3,150.00	.....	3,150.00
Mail chute	600.00	50.00	550.00
Plumbing	5,660.00	500.00	5,160.00
Elevator plant	17,706.00	4,000.00	13,706.00
Piping and radiators	7,679.00	1,535.00	6,144.00
Wiring and fixtures	3,000.00	.....	3,000.00
Vaults	3,840.00	90.00	3,750.00
Sidewalk and curb	391.60	245.60	146.60
Concrete floor basement	648.30	448.30	200.00
Cleaning up	.....	.....	1,400.00
Scaffold	.....	.....	1,700.00
	$217,131.00	$91,306.00	$128,925.00
Deduct for junk			1,320.00
			$127,605.00

I hand you herewith the award of the appraisers on the above building, together with an itemized statement of the loss.

This building was of rather peculiar construction, the exterior walls of extra thickness, the first story faced with stone ashlar and the other richly carved; all window jambs above first story were of terra cotta stories with pressed brick, terra cotta and molded belt courses of stone ornamented with a heavy terra cotta cornice at the roof line; this cornice was of delicate design, rich in ornamentation. The basement walls were of brick, concrete floor over the entire basement, floors above supported on steel columns, beams and girders; the girders were of extremely long spans and very light construction; floor arches of tile. All sub-partitions, except on first floor, were of limeotell; those on first floor hard tile, adamant plaster with molded cornice, hall and corridor floors of tile and mosaic, 5-4 Ga. flooring of strips with space filled with concrete.

You will note the light damage done to the common brick, the most of this being in the light court on the north and west walls; the pressed brick were a total loss, as they were badly smoked and burned—what were in good shape would have to be removed in order to reset the terra cotta. The damage to the stone ashlar, about 25%, was less than the actual damage, as I was able to

hold this down to offset the excessive loss on the terra cotta.

The heavy loss on steel was owing to the long spans and light construction, which could not stand the heat, and owing to the extra heavy brick walls were held in place so that when the steel expanded the beams were forced up or down in the center; some were deflected 3 ins., others crowned 2 ins., and were left in such shape that we allowed some of them new and others were to be taken out and turned over. Owing to the steel being warped and twisted so badly, it broke the bond on the floor arches and caused a damage of 50%, otherwise the damage on the arches would have been light. The limeotell partitions were a total loss. The hard tile partitions sustained only a 10% loss. The loss on ornamental iron was light, as the stairs and elevators were enclosed with brick walls.

The damage to elevators, plumbing, steam pipes and radiators was excessive, owing to the inflammable nature of the stock on the various floors. Our salvage on these items was in the basement. (Signed) H. N. Leighton.

EQUITABLE BUILDING.—No details of sound value and claim filed, other than claim for total amount of insurance. Appraisal cheerfully assented to, as in case of Calvert Building, being the same owners.

The adjustment resulted as follows: Sound value, $1,037,965; loss, $771,595.51. O. W. Norcross named by assured; S. R. White named by companies; Chas. T. Wills, umpire. Award signed by all three. Insurance, $760,000; 80% co-insurance clause on all policies. Companies pay $706,204.61; assured contributes $65,390.90; total, $771,595.51. Following are details of award:

SUMMARIZED STATEMENT OF SOUND VALUE AND FIRE LOSS OF EQUITABLE BUILDING.

	Sound value.	Salvage.	Fire loss.
General conditions	$6,950.00	.....	$6,950.00
Masonry	121,674.00	59,214.00	62,460.00
Granite	76,797.00	29,572.00	47,225.00
Roof	6,528.00	2,528.00	4,000.00
Exterior marble	8,609.00	3,109.00	5,500.00
Steel and cast iron ..	93,367.00	53,705.00	39,662.00
Ornamental iron	51,650.00	18,719.00	32,931.00
Fireproofing and terra cotta floors	68,804.00	4,000.00	64,804.00
Interior marble	56,250.00	5,500.00	50,750.00
Terra cotta and setting	26,170.00	8,170.00	18,000.00
Safes	20,000.00	5,516.00	14 484.00
Carpentry work	102,120.00	620.00	101,500.00
Plastering	36,951.00	.....	36,951.00
Wire lath and plastering	6,342.00	.....	6,342.00
Painting	16,855.00	.....	16,855.00
Glass and glazing	15,360.00	.....	15,360.00
Hardware	6,600.00	100.00	6,500.00
Wall tiling	18,590.00	.....	18,590.00
Asphalt floors	6,000.00	.....	6,000.00
Turkish baths	7,008.00	.....	7,008.00
Staging	5,000.00	.....	5,000.00
Cleaning out building..	.....	.....	8,500.00
Architects' fees	18,930.00	10,300.00	8,630.00
Furniture	55,520.00	14,724.00	40,796.00
Boiler plant, etc.....	19,823.00	13,932.02	5,890.98
High pressure piping..	8,183.88	4,630.00	3,553.88
Heating and ventilating apparatus	37,385.00	3,880.00	33,505.00
Generator plant	22,646.00	14,676.00	7,970.00
Elevators	54,969.65	17,950.00	37,019.65
Plumbing, fire pump, etc.	36,290.00	2,575.00	33,715.00
Electric wiring	19,800.00	.....	19,800.00
Fixtures	6,793.00	1,450.00	5,343.00
	$1,037,965.53	$274,870.02	$771,595.51

In handing you the appraisers' award and summarized statement showing sound value, loss and damage, and before entering into the details of the damage and percentage of loss sustained, will first give you a description of the building:

The ground area floor space for three stories is 21,975 sq. ft. each; floor space, third to tenth story inclusive, is 19,795 sq. ft. each, making a total of 2,857,798 cu. ft. Basement used for storage and the mechanical plant. This plant was of sufficient size to furnish heat, light and power to operate the Calvert Building, a large 14-story office building connected by a tunnel. Ground floor was used for general offices and Turkish bath room. First floor: in front, safe deposit, bankers and brokers; in rear, restaurant, offices and small shops. Balance of the building was fitted up for general offices and law library. The general plan of the building is similar to other office buildings throughout the country. The construction is known as the "cage form." The columns were square cast iron, bolted together, with cast lugs to receive the girders. These girders were 20-in. steel bolted to the columns. The beams were light 9-in. steel, bolted to the girders at right angles about 8 ft. centers, with a light channel iron against the walls. The roof girders were of box construction, with beams similar to the floors below. The ceiling was of T-irons hung from the roof girders. This entire frame was strongly bolted together and formed a self-supporting structure independent of the walls.

The outside, area and court walls were independent, and rested on their own foundations, and were merely an enclosure and did not carry any of the weight of the interior structure. The stairs were of cast iron with slate treads. In the offices of the several floors were iron vaults covered with fireproofing. Also a large number of safes on the different floors.

The outside wall of this building was brick, faced three stories on three sides with granite, and above this granite it was faced with pressed brick and terra cotta, with granite sills. The alley side was faced with pressed brick, and granite sills and belt courses. The court area walls were faced with enameled brick, with granite sills and belt course. The cornices were of terra cotta and covered with a marble coping. The elevator shafts and stairways were lined with glazed tile. The floor arches were of light 6-in. hollow tile, end construction with no concrete on top. The partitions were constructed of what is known as limeotile. The ceiling under roof was made of limeotile in large blocks laid on T-irons. The plastering throughout the building was of lime and sand. The columns and beams were covered with limeotile. The lower corridor floors and banking rooms were of mosaic on concrete. The upper corridor floors were of asphalt laid on wood. All other floors throughout the building were constructed as follows: A 4 × 4 of wood was laid on 9-in. steel beams and on these was laid a 2-in. plank resting on the 4 × 4 every 8 ft., and on the crown of the tile arch in the center, and on top of this was a ⅞-in. yellow pine finished floor. The main entrance corridor and cross corridors and two banking rooms were wainscoted and finished in marble and mosaic decorations. The balance of the entire building was finished in red oak cabinet finish, except law library and restaurant on top floor, which were paneled on sides, with parquetry floors and ceiling highly decorated.

On the ground floor on street side were constructed five bay windows built of wood, and the burning of these alone caused a damage of at least $2,000, as there was but little damage done by the burning out of the interior woodwork on other openings.

In further explanation of summarized statement, would say that the percentages of loss are greater than they appear, as at the bottom of summary appear "Staging," "Cleaning out building," and "Superintending." These items should have been figured in on each item where they belonged, but as the umpire settled them in this way they were not changed.

The masonry shows a loss of over 52%. This was caused largely by the area and light shaft being faced with glazed brick. The granite shows a loss of 60%, and no heat or fire from the outside on one street front, except that caused by the burning of the above-mentioned

TABLE I.—PROPORTION OF VALUE AND FIRE DAMAGE IN THE VARIOUS ITEMS OF CONSTRUCTION FOR EIGHT FIREPROOF OFFICE BUILDINGS IN THE BALTIMORE CONFLAGRATION.

Classified Construction Items.	Union Trust.		Calvert.		Herald.		Continental.		Equitable.		Mer. Nat. Bank.		Marvland Trust.		C. & P. Tel. Co.		Average.	
	A%.	B%.	A%.	B%.	A%.	B%.	A%.	B%.	A%.	B%.	A%.	B%.	A%.	B%.	A%.	B%.	A%.	B%.
Foundations	**5.02**	**1.4**	**4.87**	**.8**	**7.25**	**4.6**									**4.3**	**3.9**	**5.5**	**2.5**
Excavations and back filling	1.22	.....	1.25	.....	3.07	.....									4.3	3.9	2.21	97
Shoring banks and holding adjacent property	.....	.....	1.6	.....	.....	.....									.....	.....	1.6	.....
Foundations, footing and concrete	4.4	3 2	.74	.....	5	3.8									.....	.....	3.38	2 33
Rubble Stone and granite pier caps	.....	.....	.65	.....	.....	.....									.....	.....	65	.....
Sidewalks and curbs	.....	.....	.13	10.06	.18	37.3									.....	.....	.155	23 68
Steel Frame	**18.6**	**1.08**	**14.54**	**1.2**	**19.52**	**30.67**	**9.9**	**9.4**	**9.00**	**42.5**	**10.1**	**11.6**	**11.4**	**6.8**	**17.5**	**.74**	**18.195**	**12.98**
Material	.....	.....	11.79	.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11 79	5
Erection	.....	.....	1.7	.68	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1 7	68
Shop drawings	.....	.....	.49	3.57	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	49	3 57
Painting	.....	.....	.24	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	24	.....
Teaming	.....	.....	.32	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	32	.....
Mason Work	**23.76**	**57.2**	**28.50**	**45.6**	**24.15**	**58**	**30.15**	**42.5**	**31.81**	**69.**	**37.2**	**50**	**29.94**	**66**	**32.5**	**36.7**	**31.81**	**53.125**
Brick—common	10.1	31 8	6.89	5.6	11.21	28.75	.....	.....	.....	.....	.....	.....	8.58	55 6	13.5	33 4	8.25	31.05
" face or pressed	.....	.....	1.82	48.6	1.26	100	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1 54	74 3
" enameled	.....	.....	.86	7.1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	80	7 1
" cleaning and pointing	.....	.....	.21	65.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	21	65 9
Terra cotta	4.34	1.00	7.61	73.6	5.07	100	3.9	72.2	2.5	68 8	.....	.....	3 5	75.4	.....	.....	4.48	81 6
Stone	2 55	95	4.22	47.5	9.74	40.31	4.05	58.4	7.4	61.5	27 3	52.4	8 7	100	9.4	61 4	9.12	64 5
Marble	.....	.....	.....	.....	.....	.....	.....	.....	.83	65 8	.....	.....	.....	.....	.....	.....	83	63 8
Wall lining or furring	.77	50	.....	.....	.....	.....	.....	.....	1.8	100	.....	.....	.....	.....	.....	.....	1 28	75
Floor arches roof, etc	3 87	40	4.73	7.5	3.68	90	6.8	55	6.6	94.2	3.4	69.7	3.6	70.5	6.6	27.6	4 91	51 7
Cinder concrete filling over floor arches	.57	80	.58	66.66	.49	100	.....	.....	.....	.....	.....	.....	.....	.....	6.0	14.5	1 91	65 3
Partitions	1 56	80	1 88	89.2	3.1	58 5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2 18	89 2
" cleaning and wrecking	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Safety deposit vaults	.....	.....	.....	.....	.....	.....	7.6	1 3	.....	.....	.....	.....	5.16	.461	.....	.....	6 38	0 88
Miscellaneous scaffolding, shoring and wrecking	.....	.....	.....	.....	.....	.....	.....	.....	.48	100	.....	.....	.....	.....	.....	.....	48	100
Miscellaneous masonry	.....	.....	.....	.....	.....	.....	7.8	48 4	11.70	51 3	6.5	36.5	.....	.....	.....	.....	8.66	45 4
Equipment	**19.18**	**56.7**	**24.54**	**82**	**15.96**	**82.5**	**18.69**	**78.5**	**26.71**	**52**	**15.28**	**45.5**	**21.23**	**55**	**12.69**	**58**	**19.27**	**62 52**
Elevator plant	7.6	33.3	7.68	61.6	8.15	77.4	5	61.01	5.2	67.4	3.8	50.2	7.7	36.9	4.02	44.3	6 15	54 01
Plumbing	3.26	96.4	3.55	88.9	2.61	91.2	4.13	75.9	3.5	92.9	3.7	60.3	3.4	63.3	3.36	71.9	3 43	80 1
Heating system	4.6	39.	7.00	91	3.54	80.	4.2	73.9	3.6	89.6	2.2	49.9	6.7	39.7	4.15	35.8	4.5	62 3
Boiler plant	.....	.....	.....	.....	.....	.....	.....	.....	1 9	29.7	.....	.....	.....	.....	.....	.....	1.9	29 7
Lighting system, wiring and fixtures	2.54	80.8	5.05	98.4	1.38	100	2.03	98.08	1 9	100	1.6	59.3	3.	100	1.16	90.6	2.33	90 9
Dynamos, switchboards, etc	.....	.....	.....	.....	.....	.....	.....	.....	2.18	35.2	.....	.....	.....	.....	.....	.....	2.18	35 2
Fixtures	.7	100	.49	100	.....	.....	1.05	75 9	.65	78.7	.....	.....	.....	.....	.....	.....	72	88 65
Mail chute	.48	98	.27	38.3	.28	91 7	.18	100	.....	.....	.33	100	.43	100	.....	.....	32	88
Filter plant	.....	.....	.44	9.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	44	9
Refrigerating plant	.....	.....	.....	.....	.....	.....	.93	70.08	.....	.....	.....	.....	.....	.....	.....	.....	03	70 8
Safes	.....	.....	.....	.....	.....	.....	.....	.....	1 9	72.4	.....	.....	.....	.....	.....	.....	1 9	72 4
Vault and safe doors	.....	.....	.....	.....	.....	.....	.63	93 9	.....	.....	3.6	20.2	.....	.....	.....	.....	2 11	57 1
Flash signals and indicators	.....	.....	.....	.....	.....	.....	.54	100	.....	.....	.....	.....	.....	.....	.....	.....	54	100
Turkish baths	.....	.....	.....	.....	.....	.....	.....	.....	.68	100	.....	.....	.....	.....	.....	.....	68	100
Furniture	.....	.....	.....	.....	.....	.....	.....	.....	5.4	73.5	.....	.....	.....	.....	.....	.....	5 4	73 5
Piping high pressure	.....	.....	.....	.....	.....	.....	.....	.....	.70	43.4	.....	.....	.....	.....	.....	.....	70	43 4
Trim and Finish	**26.06**	**98**	**27.56**	**94**	**22.82**	**85.5**	**26.20**	**94**	**28.78**	**89.5**	**26.63**	**98**	**24.89**	**82**	**23.04**	**72.5**	**29.99**	**84 18**
Carpentry—Rough	2.03	100	2.59	98.1	.22	100	10.9	99 6	9 8	99.4	5.4	72.7	7.9	100	1.6	94.7	5.05	96 1
" —Finish	5.27	99.2	4.31	93.4	.51	100	.....	.....	.....	.....	.....	.....	.....	.....	5 7	96.9	3 94	97 3
Hardware—Rough	.32	90.7	.29	72.5	1.7	100	.....	.....	.64	98.5	.9	81.1	1.16	94.5	1.95	87.2	99	89 2
" —Finish	.74	99.5	.88	98.2	5.1	100	.83	100	.....	.....	.....	.....	.....	.....	.....	.....	1 88	99 4
Marble	6.74	97.8	7.11	97.6	1 42	100	10.5	94.5	5.4	90.2	10.1	75.3	6.2	100	2.8	99.9	6.36	91 2
Mosaic	.14	100	.....	.....	1.99	97.7	.....	.....	.....	.....	1 2	77.4	.....	.....	.....	.....	1.11	94 1
Glass	1 44	100	9	99.1	1.13	100	1.4	100	7.5	100	1.4	89.5	.....	.....	.89	100	1.23	96 1
Slate	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Plastering	2.94	98.6	3.05	97.4	2.96	100	3.9	100	4 21	100	3.7	69.2	2.7	100	1.4	100	3 98	88
Fresco	.88	100	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	88	100
Paint and Varnish	2.00	99.4	1.34	100	1.45	100	2.9	100	1 6	100	1.4	100	2.9	100	1 5	100	1 88	99 8
Office partitions (wood and glass)	2.65	97.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2 65	98
Ornamental iron	9.70	94 5	5.87	37.1	4.62	36.1	6.4	76.6	5.0	63.8	10.5	51.3	5.5	31.7	6.8	25.9	6.79	61
Skylights and sheet metal	.71	70	1.22	40.4	1.54	95.3	.37	37.7	.63	61.3	.83	21.6	.53	100	2.4	87.7	1 02	73
Office grill	.5	100	.....	.....	.19	100	.....	.....	.....	.....	1.2	34.3	.....	.....	.....	.....	.83	67
General Expenses	**1.88**	**70**	**1.92**	**5.42**	.....	.....	**5.17**	**48**	**4.81**	**77**	**.86**	**73.97**	**11.2**	**100**	**6.94**	**14**	**4.58**	61 39
Miscellaneous	1 83	70	1.92	5.42	.....	.....	.87	82.3	.67	100	.36	73.97	10	60	1.94	89.5	2.43	93
Architects' fees, etc	.....	.....	.....	.....	.....	.....	4.9	39.07	1.82	45 6	.....	.....	1.	100	5.0	.....	3.91	1 2
Permits, bond, survey, insurance, etc	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1 82	100
Cleaning out débris after fire	.....	.....	.....	.....	.....	.....	.....	.....	1.82	100	.....	.....	.....	.....	.....	.....	.....	.....

wood bay windows. The roof shows a loss of 60%, largely caused by being compelled to tear it off to repair damage. Exterior marble, 65%. Steel and cast iron, nearly 100%; this was caused by the falling of safes, which stripped the fireproofing off of the steel, and that bent and warped the beams. Ornamental iron, 60%. Fireproofing, total wherever the heat reached it. Terra cotta, nearly 70%. This loss was increased on account of the expense of taking out and resetting. Vaults, 73%; many of these were built on wood floors, and many of them fell, not only being badly wrecked themselves in falling, but causing considerable additional loss to steel work. These, with many of the private safes that were in the various offices, in falling crushed through the arches and bent and damaged the beams, materially aiding in wrecking the interior of the building.

Carpentry work, plastering, painting, glazing, hardware, wall tiling, asphalt floors and Turkish bath room were nearly all a total loss. The mechanical plant, including elevators, boilers and heating, electric plant and fixtures, plumbing, ventilating and all wiring and gas pipes, shows a loss of 70%; the salvage being on the portion that was in the basement. The furniture and fixtures show a loss of 73%; the salvage was in the safety deposit vaults and fixtures.

Had this building been properly constructed there would not have been over a 50% loss. This was among the first so-called "fireproof" buildings, and everything was made as light as possible to cheapen the cost of construction. The floor beams were not only light, but were spaced 8 ft. on centers, with the floor tiles arched between, there being no cement over crown of arch. When the heavy flooring above these arches burnt through, the steel being exposed warped and twisted, and the arches in many cases fell of their own weight. Others that had safes over them, when the floors burnt away and let the safes down, the arches gave way and the safes dropped, crushing through floor after floor until they reached the basement and in their passage bending the steel and wrecking the arches. A large portion of the damage would have been saved had the fireproofing been properly cemented, proving conclusively that too much care cannot be taken in looking after the construction of a building if the fireproofing is to be of any practical use. (Signed) Samuel R. White.

MERCHANTS' NATIONAL BANK.—Detailed statement of claim, though early called for, was not presented until March 22, on which date the following was filed: Sound value, $473,280.63; loss, $293,685.07. Appraisal was obtained with the following results: Sound value, $405,056.67; damage, $220,576.19. L. H. Focht named by assured; Samuel R. White named by companies; George F. Payne, umpire; umpire not called. Total insurance, $335,000; 80% co-insurance clause not operative. Details follow:

SUMMARIZED STATEMENT OF SOUND VALUE AND FIRE LOSS ON MERCHANTS' NATIONAL BANK BUILDING.

	Sound value.	Salvage.	Fire loss.
General conditions	$1,460.00	$380.00	$1,080.00
Masonry and concrete..	26,302.00	16,702.00	9,600.00
Granite	110,703.00	52,703.00	58,000.00
Structural steel, and painting same	41,000.00	36,250.00	4,750.00
Ornamental iron	42,630.00	20,780.00	21,850.00
Fireproofing and concrete	13,705.47	4,156.71	9,548.76
Vaults and safe doors..	14,680.00	11,710.00	2,970.00
Carpentry — rough and finished	22,000.00	6,000.00	16,000.00
Plastering — plain and ornamental	14,960.00	4,603.62	10,356.38
Painting, lettering and decorating	5,763.00	.....	5,763.00
Glass and glazing.....	5,842.00	614.50	5,227.50
Hardware	3,650.00	690.00	2,960.00
Mail chute	1,320.00	.....	1,320.00
Copper roof and skylights	3,343.00	2,622.00	721.00
Fire shutters	896.00	63.00	833.00
Interior marble	41,000.00	10,125.40	30,874.60
Mosaic and terrazzo floors	4,866.50	1,098.25	3,768.25
Bank fixtures, lockers and partitions	4,853.70	3,188.00	1,665.70
Plumbing, gas fittings and fixtures	15,116.00	5,996.00	9,120.00
Electric elevators	15,265.00	7,610.00	7,655.00
Electric wiring	6,605.00	2,688.00	3,917.00
Slate slabs on vaults..	250.00	50.00	200.00
Heating and boilers ..	8,846.00	4,430.00	4,416.00
Clearing rubbish, shoring and scaffolding ..	.....	.....	5,360.00
Superintending reconstruction	.....	.....	1,620.00
General damage to structure (compromise) ..	.....	.....	1,000.00
	$405,056.67	$192,460.48	$220,576.19

I hand you herewith award and summarized statement of sound value and loss and damage on the Merchants National Bank, an eight-story and basement bank and general office building, having a ground area 6,290 sq. ft.

The building was constructed of cast iron posts built in outside walls; box girders running full length across building, with no interior columns. At right angles with these beams were framed steel girders to support the floor arches and floors. The roof was constructed in the same manner with a steel constructed hanging ceiling. Three sides of this building, including bay windows, cornices and all belts and projections, were faced with granite and backed up with brick. The area and side walls were of common brick. The fire-proofing on floors and roof was of 8-in. hard tile, flat construction, filled in on top with 5 ins. of concrete, in which was imbedded the floor strips. The partitions were built of 4-in. hollow tile, and were all a total loss above the third floor. The ceiling under roof was of limeotell blocks and was a total loss. All of the woodwork, except part of the basement, banking room, first floor and about half of the third floor, was a total loss. The plastering in entire building, except in rooms named above, was a total loss. The loss to the floor arches consisted of damage on the under side, as the plaster was of common mortar and came off as soon as heated, and the under side of arches are chipped and will require wire lath to hold the plaster.

As you will see, the painting and decorating was a total loss, and a large percentage of loss on the mechanical plant and ornamental iron. The main loss to the structural steel was the ceiling under the roof, and the scraping and repainting of the box girders, as the most of the fireproofing will have to come off and be renewed. The granite on the east end of the building is a total loss. The three bay windows on the north, three stories high, will have to come down and be rebuilt, and the rest of the granite on side and front is badly damaged by scaling from the heat. The brick walls in areaway will have to be refaced, and the entire granite not renewed will have to be sandblasted. The manner in which this building is constructed makes it expensive to repair, as a quantity of material not damaged has to be removed or shored up in order to replace the damage. In this building, as in others, material classed as fireproof costs the companies 25% more to replace than it would if it had been entirely destroyed. The granite and marble has shown a greater percentage of loss in this building and others than any other material of its class. Limeotell has proved to be worthless, and tile partition, on account of the lightness and poor construction, has been a failure, as they have not only been a total loss, but have been a cause of big expense in the removal of the debris. Marble and granite trimmings have proved a failure in most cases when subjected to any great degree of heat. Terra cotta, where well made and set properly and backed in, has in many cases stood the test and has not shown the percentage of loss that marble and granite have shown.

(Signed) Samuel R. White.

CONTINENTAL TRUST COMPANY BUILDING.—Detailed statement furnished by this company was as follows: Sound value, $1,018,564.42; loss, $727,584.61. There being considerable differences in opinion as to the amount of loss, it was decided to get an *ex parte* estimate. William J. Doyle, of Doyle & Doak, of Philadelphia, was engaged to make same, and fixed the amount of loss at $466,604. An appraisal was entered into, the following appraisers being named: Ralph Sterrett named by assured; Samuel R. White named by companies. After considerable delay Mr. Chas. T. Wills was named as umpire by assured's appraiser and immediately accepted by Mr. White. Unfortunately, after a delay of several weeks it transpired that Mr. Wills was unable to serve, whereupon J. Hollis Wells, of New York, was selected in his place.

The adjustment of this loss has been extremely troublesome, annoying and unsatisfactory throughout. The award was signed by umpire and assured's appraiser in absence of Mr. White. The amount named in award is believed to be in excess of the actual loss. Owing to the irregularities, the committee deemed it wise to lay the case before the companies, which was done at a meeting in New York on June 2. While the feeling was that the companies had not received fair treatment, it was decided that it was inexpedient to contest award, and the committee were instructed to close the loss. The figures are as follows: Sound value, $1,028,461.60; loss, $666,328.55; total insurance, $500,000, of which $290,000 is with and $210,000 without 80% co-insurance clause; distributed as follows: Companies without co-insurance pay $210,000; companies with co-insurance pay $234,859.61; assured contributes $221,468.44; total, $666,328.55. The following are the details:

SUMMARIZED STATEMENT OF SOUND VALUE AND FIRE LOSS OF CONTINENTAL TRUST BUILDING.

	Sound value.	Salvage.	Fire loss.
General conditions ..	$2,811.00	$500.00	$2,311.00
Masonry	79,793.61	41,158.13	38,635.48
Granite	41,706.32	17,360.32	24,346.00
Steel	101,695.00	92,141.85	9,553.15
Fireproofing	63,030.99	28,894.00	34,136.99
Terra cotta	39,982.50	11,107.50	28,875.00
Painting and decorating	29,600.00	.....	29,600.00
Carpentry and mill work	111,912.64	412.64	111,500.00
Ornamental iron.....	65,756.95	15,386.95	50,370.00
Plastering and lath..	29,997.00	.....	29,997.00
Marble and setting..	108,000.00	5,900.00	102,100.00
Vault doors	6,500.00	400.00	6,100.00
Finished hardware...	8,500.00	.....	8,500.00
Cement floors and concrete	7,138.64	2,816.69	4,321.95
Glass and glazing...	14,427.00	.....	14,427.00
Mail chute.....	1,850.00	.....	1,850.00
Scaffolding	.....	.....	2,500.00
Safety deposit vault..	78,000.00	77,000.00	1,000.00
Sheet metal and roofing	3,751.57	1,588.75	2,162.82
Boilers, heating and ventilating	43,151.00	11,270.00	31,881.00
Plumbing, sewerage and gas	42,441.00	10,245.00	32,196.00
Electric wiring.....	20,855.00	400.00	20,455.00
Refrigerating plant..	9,583.00	2,798.00	6,785.00
Elevators and plant..	51,300.00	20,000.00	31,300.00
Flash signals and indicators	5,600.00	.....	5,600.00
Electric fixtures.....	10,800.00	2,600.00	8,200.00
General removal of present debris.....	.....	.....	7,983.00
Architect and superintendence	50,278.38	30,636.22	19,642.16
	$1,028,461.60	$372,616.05	$666,328.55

In submitting to you my report and handing you the summarized figures on which this building loss was settled by the assured's appraiser and the umpire, and before entering into the loss, will first give you a description in general, explaining its construction.

This building was of modern construction and was supposed to be the best built building in Baltimore, and should and would have stood the test and suffered less than any other had the contractor used more care in its construction. In this building, as in some others, the material stood the test, but the faulty construction caused the loss.

This building was a 16-story and basement building, used on the ground floor for safety deposit vaults and small shops. The first and second stories were used for banking purposes. All above these floors was used for offices. The structure was all steel, and carried the weight of the entire building, and was so constructed that each story carried the weight of its enclosures, and any portion of the walls could be removed without destroying that above or below it, making it an easy building to repair, and there was no reason why the walls should have been condemned and figured down. The first three stories were veneered with granite and backed up with brick. Above this was a light brick wall veneered with pressed brick, with terra cotta trimmings and cornices. These veneers were anchored to the common brick with light galvanized strips which gave way, allowing the brick to fall off. The terra cotta was of good quality, and would have sustained less loss had it been set properly and backed up with brick. The floor arches were made of 15-in. hollow tile and stood well, as most of the plastering remained on the ceiling and protected the under side. The partitions and wall tiling were light and poorly constructed, and the companies, in addition to paying a total loss on them, paid for the removing. Floors of all offices were of wood, laid on wood strips, bedded in concrete. Corridors and banking room floors were of marble. The finish and fixtures to all offices were of mahogany. The halls, corridors and banking room were wainscoted with marble. All steel was fireproofed throughout except the roof girders in the unfinished part of the attic and some cast-iron columns in the basement, and these coverings stood well except where the heating, gas and water pipes were in the same enclosure around the columns.

In figuring the percentage of loss up on the different kinds of work, the scaffolding, cleaning up and superintendency should have been added in each item where they belong. This was agreed upon by Mr. Sterrett and myself, but the umpire, in bringing in his decision, changed many items and did not act upon differences only.

The masonry and foundations included all brick work, and this sustained a loss of 48½%. The granite sustained a loss of 60%. The damage to this granite was caused largely by having to remove good granite to get at the damaged. The structural steel sustained a loss of 9½%. Most of this loss was in the areaway, and was of a very light and poor construction. The fireproofing sustained a loss of 54%. This included total for all partitions and wall linings, and as the umpire did not separate the arches, I did not know what percentage they were. The terra cotta sustained a loss of 52%, and a large part of this loss was caused by the inferior manner in which it was set. Painting and decoration, carpenter and mill work was practically a total loss. The ornamental iron sustained a loss of 74%, but there is lots of this material that can be used again which is not materially damaged but was condemned by the umpire. The plastering and metal lath was a total loss. There was a small salvage of marble which was in the banking rooms which was not destroyed. The vault doors were practically a total loss, as decided by the umpire, but many of them could be used and repaired, as the contents were not destroyed in many of them.

Finished hardware was a total loss. The cement floors and concrete suffered a loss of 60½%. The mechanical plant suffered a loss of 74%; this includes electrical work, wiring, etc.

In submitting this report I would say that most of these amounts were fixed by the umpire, and I consider many of them far in excess of the loss.

(Signed) Samuel R. White.

MARYLAND TRUST COMPANY BUILDING.—Detailed statement furnished by this company was as follows: Sound value, $465,644.13; loss and damage, $312,783. Appraisal was entered into, the following being named: O. G. Selden by assured; Geo. F. Payne by companies; J. Lindsey Little, umpire. The award, which was signed by all, is as follows: Sound value, $404,005; loss, $242,279. Insurance was as follows: $156,632.78 without co-insurance clause; $24,661.24 with 80% co-insurance clause; companies without co-insurance pay $156,632.78; companies with co-insurance pay $18,486.47; assured contributes $67,159.75; total, $242,279. The following are the details:

SOUND VALUE AND LOSS IN THE MARYLAND TRUST CO. BUILDING.

	Sound value.	Loss.
Permits, bond, survey, insurance, etc.	$5,000.00	$5,000.00
Brick work, wrecking, etc.	37,400.00	20,785.00
Cut stone and curb.	36,400.00	36,400.00
Ornamental terra cotta.	14,596.00	11,000.00
Fireproofing	14,987.00	10,559.00
Plastering	11,060.00	11,060.00
Roofing and sheet metal.	2,221.00	2,221.00
Marble mosaic and terrazza.	25,785.00	25,785.00
Painting and glazing.	12,140.00	12,140.00
Structural steel	47,378.00	3,000.00
Ornamental iron	23,000.00	5,000.00
Carpenter, mill, labor and lumber	32,850.00	32,850.00
Hardware	4,822.00	4,557.00
Electric wiring and fixtures.	12,518.00	12,518.00
Plumbing and gas fitting.	14,200.00	8,987.00
Heating and ventilating.	29,000.00	11,524.00
Elevators	32,000.00	11,800.00
Mail chute and clock.	1,780.00	1,780.00
Bank vault	21,500.00	100.00
	$378,637.00	$227,066.00
Plus 10%	$37,863.00	$22,706.00
	$416,500.00	$249,772.00
Less 3% depreciation.	12,495.00	7,493.00
	$404,035.00	$242,279.00

NATIONAL MECHANICS BANK BUILDING.—The award in connection with the adjustment of loss on this building was as follows: Sound value, $156,854.87; insurance, $60,000, without co-insurance; fire damage, $149,012; insurance loss, $60,000. The following are the details:

	Sound value.
675,000 brick at $16.	$10,700.00
Additional for front and mold brick.	1,200.00
Fireproofing—floors, partitions and roof.	10,500.00
Lumber for floors, sleepers, etc.	4,500.00
Mill work, doors, frames, sash and trim.	7,650.00
Iron framing, columns, beams for floor and roof	14,413.00
Heating pipes, radiators, etc.	5,836.00
Exterior marble complete.	35,000.00
Interior marble complete.	22,800.00
Plastering	3,400.00
Painting, glazing, etc.	1,700.00
Glass	1,240.00
Galvanized iron, copper roof, spouting, etc.	2,979.00
Carpenter work, labor and superintendence.	8,000.00
Vaults	10,000.00
Hardware, nails, etc.	950.00
Plumbing	8,335.00
Elevators	6,651.87
Foundations	.....
	$156,854.87

CHESAPEAKE & POTOMAC TELEPHONE CO.'S BUILDING.—The award in connection with the adjustment of loss on this building was as follows: Sound value, $115,000; insurance, $43,979.03, with 80% co-insurance clause; $12,993.80 without co-insurance; companies with co-insurance pay $21,230.48; companies without co-insurance pay $10,129.21; assured contributes $13,053.08; total damage $44,412.77. The following are the details:

	Sound value.	Loss.
General conditions	$1,080.00	$532.00
Excavation and masonry, footings and basement	4,986.00	150.00
Granite and brown stone.	10,805.00	6,675.00
Common and face brick.	15,580.00	5,200.00
Concrete and asphalt floors	6,890.00	1,000.00
Fireproofing	7,600.00	2,100.00
Interior marble	3,190.00	2,900.00
Plastering and wire lath.	1,660.00	1,660.00
Sheet and metal work.	2,760.00	2,420.00
Structural iron	20,180.00	150.00
Architectural iron	7,850.00	2,032.00
Plate and wire glass.	1,025.00	1,025.00
Painting and decorating.	1,760.00	1,760.00
Hardware, fine and rough.	1,000.00	950.00
Boilers, heating and ventilating.	4,772.00	1,710.00
Finished carpentry	6,340.00	6,340.00
Rough carpentry	1,878.00	1,777.77
Plumbing	3,862.00	2,775.00
Elevators	4,625.00	2,050.00
Electric wiring and gas fixtures.	1,331.00	1,206.00
	$109,524.00	$44,412.77
Plans, specifications and superintending, 5%	5,476.00	
	$115,000.00	

GENERAL REPORT OF APPRAISER.—In my former reports on the buildings classed as "fireproof" I attempted to give you an idea of their construction and the uses for which these buildings were intended, and also the kind of material used in their construction. It would be useless for me to attempt to tell you how to build a fireproof building; the subject is so big that it would take volumes to tell it. Much thought and many tests have been given to materials that will stand the fire test, but the manufacturers seem to lose sight of the fact that their materials must be made and shaped to fit the places for which it is intended, and unless these materials will stand the fire test after being put in position, they are worthless.

In order to construct a good building, many things are necessary: First, the owner must be willing to furnish the necessary capital. Second, the architect, the material man and the contractor must all work together, as a good plan and good material are of no use if the plan is not carried out and the material properly put in place. Better results would be obtained if this entire work was let to one good general contractor, for when it is let out to the different trades they do not work together. One contractor will rush in and complete his part regardless of what is to follow, then another trade comes along and tears many parts to pieces in order to install his work, and by the time each trade is through the many parts of the building have been weakened and rendered worthless, so far as fireproofing is concerned. Many instances of this kind could be cited in the different buildings in Baltimore. It was no uncommon thing to see a vault or partition cut into to install some plumbing, electric wires, or heating pipes, and as a result the contents of the vault would be destroyed. Again, many of the vaults and partitions were set on a wood floor, and the vaults and partitions were not anchored together. And also wood strips were laid into the partitions. On one building five bay-windows of wood were built on the side of a granite wall, which caused a loss of at least $2,000 to the granite, as the other openings on the same side and equally exposed were damaged but little. Pipes for the different trades were placed alongside of columns, and they expanded and loosened the fireproofing, causing damage to the columns. Iron mullions and metal ties have surely sounded their death-knell. These cast mullions, being exposed to the extreme heat, expanded and forced their ends through the terra cotta sills and caps, ruining many a cap and sill that otherwise were not damaged. And where these mullions were attached to steel beams, as in several buildings, they expanded, throwing the wall out of line. Many of the buildings were not fireproofed between the ceiling and roof. Several buildings had no fireproofing on the lower flanges of the beams, and when the plastering dropped off they were subjected to the heat. Others were fastened on with metal strips which loosened and dropped off.

There is many a lesson to be learned as a result of the Baltimore fire, and the wide-awake manufacturer of building material will seek to make none but the best, and he will see that it is properly put in place, as the capitalist who puts his money into fireproof material will come from Missouri, and "will have to be shown," as in the future much will depend upon the kind of material and the manner of construction, in fixing of rates for insurance. The material that has stood the test can be spelled with five letters, and that is "brick." Next comes terra cotta, and is followed by porous and semi-porous tile.

The floor arches stood well, where properly put in, but column and girder covering, partitions and wall lining in many places failed, not so much on account of the material, but due largely to poor construction and lightness of material. Where brick was used to back up the inside of walls, but little damage accrued, but where tile was used it was poorly constructed. They lined up on the inner surface and left a hollow space between that and the wall. Mac-ite and Lime-of-Teil were totally destroyed, nothing left but rubbish, to be carted away at a large expense. Granite and marble, wherever heat came in contact with them, cracked and scaled off.

Structural steel has in this instance proved all and more than was ever claimed for it, as on the whole in the fireproof structures it has not suffered over a 5% damage. The freaks of the fire can only be explained by the different shapes and construction of the buildings and the changing of the wind. These tall buildings acted as flues and carried the heat away from some of the lower buildings that surrounded them.

Another lesson to be learned from this fire is that too much care cannot be taken in the proper construction, and the securing and putting on of fireproof material, and the old adage, that "the chain is only as strong as its weakest link" has proved itself true in this case.

A NOVEL MACHINE FOR WASHING AND DRYING BLUE-PRINTS.

The floor-space required for washing and drying blue-prints often adds materially to office rental charges. Moreover, the repeated handling of the prints in the ordinary process of washing and drying reduces the possible output of a given number of men and increases the cost of blue-printing.

The ingenious device shown in Figs. 1 and 2 has been designed to reduce the labor of blue-print work, the time required to dry the prints and the floor space necessary for the washing and drying.

A light iron framework supports two pairs of sprocket wheels (only the lower pair is shown in Figs. 1 and 2), around which pass two endless chains provided with clips to hold the "drying rods." A blue-print is folded over a rod, as shown in Fig. 1, and, as it hangs in the washing tray, a spray of water flows over the treated side of the paper, removing the ferroprussiate. As the water comes in contact with one side of the paper only, and but for a short time, the paper dries out in about one-third the time usually required. The surplus water is removed by a wiping device, shown in Fig. 1. While one print is being pulled through the wiping device, the print above is carried over the top of the machine and descends on the rear side. Finally the print reaches a position where a pair of curved castings gently disengage the drying rod from the clips on the chain, and the drying rod with its print slides down upon a drying rack. These machines are made in four sizes; the smallest size is designed to hold a print having a maximum size of 24 × 48 ins.; the largest size holds a 42 × 100-in. print.

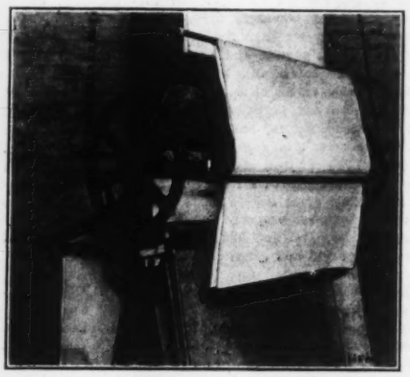


Fig. 1. A Blue-Print Washing and Drying Machine, Showing a Print Passing Through the Wiper.

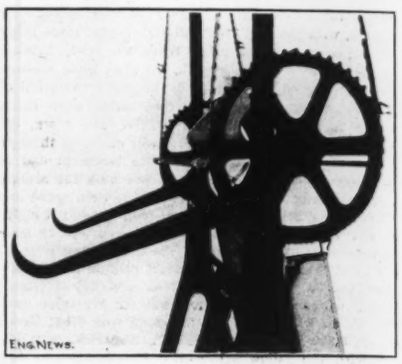


Fig. 2. Showing the Drying Rods and Rack for Holding Blue-Prints.

The inventor and manufacturer of this machine is C. F. Pease, 173 West Locust St., Columbus, Ohio.

DEVELOPMENTS IN ELECTRIC TRACTION.*

By W. B. Potter,† M. Am. Inst. E. E.

The direct-current system, with a central station feeding numerous rotary converters through the medium of three-phase high tension transmission lines, which in turn supply an overhead trolley network with direct current at a pressure of from 550 to 600 volts, is without doubt the most highly developed and best known electric traction system.

The alternating-current system may either employ single or three-phase generators and transformers. Both the generators and transformers will be three-phase where three-phase induction motors are used on the cars; and in such cases the line is equipped with two overhead trolley lines, and the track rails serve as the third conductor. When single-phase motors are used on the cars, either three-phase or single-phase generators and transformers may be used, the choice being dependent on local conditions. Three-phase systems have been extensively used in Europe, especially in Switzerland, Italy and Germany. The three-phase induction motor is particularly well adapted for service in which it is desired to control the speed of the car by means of the motors on down grades, either for the purpose of returning energy to the line, or as a measure of safety.

A great deal has been written concerning the possibilities of single-phase traction, and, as is often the case with the development of a new principle, many appear to have formed too optimistic ideas of its capabilities. While we recognize the advantage of such a system in many cases, it is a mistake to imagine that it will be a cure for all ills and revolutionize the railway world. It is well, therefore, to have a clearer idea of the advantages and disadvantages of single-phase traction, and also to analyze the reasons governing the choice of such a system. It is self-evident that the relative expenditure for equipment, operation and maintenance should be the fundamental reason governing the selection of a system for any particular service.

*Abstract of a paper presented before the New York Railroad Club, Jan. 20, 1905.

†Engineer, General Electric Co., Schenectady, N. Y.

COMPARISON OF DIRECT-CURRENT AND SINGLE-PHASE TRACTION.

The single-phase alternating-current system possesses two features which recommend its use: economy of trolley copper, due to the higher trolley voltages, and the elimination of the rotary converter. The chief advantage gained by these features is a saving in the initial cost of equipment: factors which increase in importance in proportion to the amount of power required by each car or train and with the length of the trolley line. On the other hand, the car equipments cost more than with direct current for a similar service and the same given rise in temperature of the motors. It is, therefore, apparent that the relative costs of the two systems will be materially affected by the number of cars employed.

The saving in power resulting from the elimination of the rotaries is about offset by the greater weight and slightly lower efficiency of the a. c. motor. The efficiency of the a. c. control, during acceleration, will, generally speaking, be somewhat higher than that of the d. c. system with series-parallel control. With the a. c. system fractional voltages can be obtained from the transformer on the car. Each step of the a. c. controller gives a running position which corresponds with the series and parallel positions in a d. c. controller. The potential of the transmission lines from the power station may be selected, as in the case of the d. c. system, without reference to the trolley or secondary voltage. The trolley voltage must, however, be considered from a different basis than that of the d. c. system for the reason that, in addition to the ohmic resistance of the trolley and track circuit, there is an apparent increase in resistance, due to the alternating current. This increase in apparent resistance for 25-cycle alternating current, as compared to direct current, is about 50% in the trolley wire and between six and seven times greater in the rail return. The rails being steel, the increase in apparent resistance is relatively much greater than in the trolley wire. As the resistance of the track return with large steel rails is proportionately much less than that of the trolley wire, the apparent increase in resistance for the latter and the track taken together, will be, roughly, from one-half to twice that for direct current. An alternating current at 1,000 volts is, therefore, about equivalent to 600 volts direct current so far as affecting the amount of trolley copper, and to secure the advantages of the a. c. system to a reasonable degree at least 3,000 volts or, for heavier service, perhaps 5,000 volts, must be employed.

The design of an a. c. motor as regards length of air gap and armature speed is affected by the lower average flux density. For this reason an a. c. motor is larger and heavier than a d. c. unit of the same output. The commercial a. c. motor represents a compromise in which the armature speed is somewhat higher and the air gap slightly less than would be the case in a d. c. motor of corresponding capacity. I have mentioned these facts to indicate that the maintenance of an a. c. motor will, in all probability, be greater than that of an equivalent d. c. motor, due both to the higher armature speed and the smaller air gap. The equipment of heavy locomotives with a. c. motors for high speed passenger service is a possibility, but, owing to the limitations imposed by the space available for the motors, it seems probable that two locomotives, each with four motors, would be required for service which could be performed by a single d. c. locomotive with four gearless motors. For locomotives in slow speed work, such as freight or shifting, a double gear reduction will, in many cases, be required, owing to the difficulty of winding an a. c. motor of large size for slow speeds.

In view of the extensive application of the d. c. system, it is fortunate that the a. c. motor and its control may be so arranged as to be well adapted for operation on either high potential alternating or 600-volt direct-current lines. This adaptability is an important factor in the net earnings, as the equipments are not necessarily limited at all times to a particular route, and further, where d. c. trolley lines are available, the expense of installing a special a. c. trolley is saved.

The above comparisons relating to a. c. and d. c. systems indicate certain financial and technical differences which have to be met. There is no question as to the successful operation of a. c. apparatus, and the advisability of its use when such an installation will prove financially advantageous.

COMPARISON OF STEAM AND ELECTRIC TRACTION.

The power required per ton mile for moving trains varies so greatly with conditions of traffic that any direct comparisons between electricity and steam as a motive power can only be made by assuming a given class of service. The suburban type of traffic is generally recognized as being more especially suited to electrification, and a comparison in such service of the steam locomotive and an electrically-equipped train of equal seating capacity, will be of interest.

It is admitted that the first cost of equipping a railroad electrically is higher than the initial outlay for equipping the same road with steam locomotives; but it is well-nigh impossible to make a general comparative statement as to the relative first cost. This will depend on the number of locomotives required to handle the traffic in the one case and in the other upon the density of the traffic, and it is the latter factor upon which the size of the generating station and transmission lines are dependent.

For example, assume a suburban train of four cars hauled by a steam locomotive, and a similar train operated by electric motors under the cars:

	Tons.
Weight of steam locomotive	110
4 cars, 40 tons each	160
Total weight of steam train	270

The electric equipment for these four cars to perform the same service, would weigh, approximately, 50 tons.

	Tons.
Electric equipment	50
4 cars, 40 tons each	160
Total weight of electric train	210

Tests on a steam locomotive in this class of service have shown, approximately, .07 I. HP.-hours per ton-mile and a coal consumption of 6.86 lbs. per I. HP.-hr., charging up the full amount of coal used during the twenty-four hours, whether running or idle. On the above basis, assuming coal at $2.50 per ton, we have the following as cost of coal per train mile:

I. HP-hrs. per ton-mile	.07
I. HP.-hrs. per train-mile	18.9
Lbs. coal per I. HP.-hr.	6.86
Lbs. coal per train-mile	130.
Cost of coal per train-mile, cents	14.5

The cost of electric power per kilowatt-hour is well established by records from many power stations. The following is a typical record from a station in railway service:

Coal ($2.85 per ton)	.00280
Water	.00036
Labor	.00158
Supplies	.00011
Maintenance	.00009
Total	$.00500

As the cost of coal and labor is a variable quantity we will assume $.006 as a basis. The labor and maintenance of sub-stations may be taken as 10% additional, making a total cost per KW.-hour of $.0066. The efficiency of transmission and sub-stations may be taken as 78%. The cost of power for the electric train would, therefore, be as follows:

Weight of train	210 tons.
Watt hours per ton-mile (equivalent to above .07 I. HP. hrs.)	58
KW.-hrs. per train-mile at train	12.2
KW.-hrs. per train-mile at power station	15.6
Cost of power per KW.-hr. at train, cents	0.66
Cost of power per train-mile, cents	10.3

The wages per day for a train crew in steam service may be taken as follows:

Engineer	$3.50
Conductor	3.00
Fireman	2.00
2 train hands	3.50
Total	$12.00

The crew for the electric train will be the same, omitting the fireman. In steam service this crew will make a train mileage of, approximately, 100 miles per day. In an electric service, due to its greater flexibility, it is a reasonable assumption that the crew will make a mileage of 150 miles per day. Under this assumption the wages per train-mile will be:

Steam	12 cts.
Electric	6.7 "

The maintenance of steam locomotives varies, but in this class of service 6.5 cts. per locomotive-mile seems a fair basis from the records available. The maintenance of the electrical equipment per car-mile on the Manhattan is ¼-ct., and as these equipments are larger we will assume 1 ct. per car-mile, or 4 cts. per train-mile.

A summary of the comparative cost per train-mile is as follows:

	Steam.	Electric.
Coal or equivalent electric power	14.5	10.3
Water	.5	..
Train crew	12.0	6.7
Maintenance	6.5	4.0
Supplies	.5	.2
	34.0	21.2 cts.

Assuming a yearly mileage of 50,000 miles, which is a reasonable assumption for the electric train, the yearly difference in cost of operation, in favor of electricity, would amount to $6,400, representing an interest on the total investment per train which would be more than sufficient for that usually required for the car equipment and the proportionate part of the power station and transmission. Furthermore, to this capitalized investment should be credited the cost of a steam locomotive equipment capable of making 50,000 miles per year.

As this is a brief consideration of a general example, it is hardly worth while to enter into refinement, but in nearly every case the use of electric power will make it possible to secure many incidental economies, both in utilization of rolling stock and cost of operation, the aggregate of which may be a large item.

The following comparison from statistics covering the steam and electric operation of the Manhattan Ry. (Elevated) shows the increase in traffic and the lower cost of operation per car-mile resulting from electrical equipment. The probable increase in traffic was not sufficiently recognized, prior to the electrical equipment, as to be reckoned an important factor in the earnings of the road, but its influence to this end will be better appreciated when it is remembered that during the latter period of steam service the number of passengers carried decreased each year.

	Steam. 1896.	Electric. 1904.
Date		
Operating ratio	58.1%	21.2%
Passengers carried	185,138,000	286,634,000
Car mileage	43,241,000	61,743,000
Receipts per car-mile	21.6	22.95 cts.
Total operating expenses:		
Per car-mile	13.2	9.5 "
Per passenger	2.92	2.04 "

Careful calculations should be made on each individual road considering electrification, as actual results will vary with every new set of conditions. The point at issue is whether the traffic is, or is likely to be, of such a character that the saving in operation or increased receipts will show a proper return upon the required capital.

In considering the application of electric power to freight service, the subject may be considered more strictly from the standpoint of existing traffic, as the reasons which influence the growth of passenger traffic will apply only in so far as the movement of freight may be facilitated and cheapened. Electric power in a single unit, such as a locomotive, is best suited for general freight, although there may be special cases where it will be advantageous to equip several or all of the cars in a train and control from the leading car.

ELECTRIC LOCOMOTIVES.

As with the steam locomotive, the design of the electric locomotive is influenced by the service for which it is to be used.

The bogie truck type following the precedent of the motor car was the first to come into general use and it has become a well-established type for general service in high-speed haulage, or for yard shifting where there are many curves.

The articulated type is well represented by the locomotives originally supplied to the B. & O. R. R. for the Baltimore Tunnel.* This type is much the same as two coupled locomotives, with the disadvantage of not being two independent units, either of which can be operated or repaired independently of the other.

The rigid frame type is one in which all axles are held square with the frame and parallel to one another. The mechanical design is strong and simple and well adapted for heavy slow-speed haulage. The additional equipments for the B. & O. tunnel are of this type.† Two of these locomotives, with a total weight of 160 tons on the drivers, as shown in Fig. 1, are ordinarily coupled together and controlled as a single unit.

The requirements of high-speed passenger service are especially severe, demanding a locomotive of large power and consequently of heavy weight, as well as one possessing a reasonably flexible wheelbase.

The locomotive,‡ recently designed and built by the General Electric Co. and the American Locomotive Co. for the New York Central Railroad, is the result of a careful study of many different types. This electric locomotive differs from any that have previously been built, in having a rigid frame for the drivers and pony trucks at each end for guiding, and in having motors whose mechanical construction is radically new.

CURRENT CONDUCTORS AND COLLECTORS.

The method of conveying electric power to a car or train is influenced by the size of equipment and conditions under which it operates. The simple trolley and wheel in general use has been surprisingly satisfactory in service much more severe than that for which the trolley wheel was originally considered. The limitation of its capacity is rather in the life of the wheel than from any particular difficulty in collecting the current. With cars of medium size, at moderate speed, an upward pressure of 15 or 20 lbs. against the trolley wire is sufficient and the life of the wheel is frequently 10,000 miles or over. At car speeds of 50 to 60 miles an hour an upward pressure of 35 to 40 lbs. appears necessary to insure the wheel maintaining close contact with the wire over the irregularities of the suspension. This greater pressure, coupled with the larger amount of current commonly taken at such speeds, results in the rapid wearing of the trolley wheels, which is more especially noticeable on account of the large daily car mileage common to high-speed service.

Considerable attention is being given to the development of a collector for heavy service which will cost less to maintain than the present trolley wheel. The bow form of trolley, in which a sliding bar of copper or aluminum at right angles to the trolley wire replaces the trolley wheel, has been used to some extent abroad and seems to have met with considerable favor. The cars on which the bow trolley has generally been used are of comparatively slow speed and power, and such tests as have been made indicate that in the equivalent of our suburban service the maintenance of the bow trolley would considerably

*A description of these locomotives and the power plant for their operation was given in Eng. News, Nov. 29, 1894, p. 450.
†Eng. News, Aug. 27, 1903, p. 185.
‡Eng. News, Nov. 17, 1904, p. 450.

exceed that of the trolley wheel. A modification of the bow trolley in which a roller replaces the sliding bar has been used in a number of cases with excellent results. Where the trolley wire is maintained within a foot or two of uniform height, a reversible trolley contact with a pantagraph mechanism, carrying a roller for contact with the wire, can readily be applied. Where the variation in height of the trolley wire is considerable on different parts of the same line, the pantagraph construction must necessarily be of considerable size. It is customary to install two pantagraph trolleys, each collecting its share of the current, and where necessary to collect a larger amount as might be the case in locomotive work, additional trolley contacts may be installed to any extent required. A pantagraph type of trolley provided with a shoe instead of a roller is well adapted for use in connection with third-rail operation, where it is desired to make contact through special track work or road crossings where the third rail cannot be conveniently installed.

The ordinary methods of trolley wire suspension and insulation are not well adapted for high potential alternating trolley lines, and what is known as a catenary suspension of the trolley wire will probably be more generally

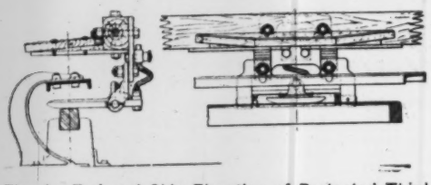


Fig. 1. End and Side Elevation of Protected Third Rail, Showing Contact Shoe.

used. In the catenary suspension the supporting cable or catenary is carried over the top of high potential insulators at the point of support and the trolley wire is attached by clips and hangers, directly to the catenary without intervening insulation. The catenary thus serves as a supplemental conductor to the trolley wire, and it may be of either steel or copper. As the trolley wire is supported at frequent intervals, the poles for the catenary can be spaced at longer distances than common with the ordinary type of trolley construction. While especially advantageous for high potential work, there is no reason why the catenary form of suspension should not be more generally employed for direct current work, and it provides a means for supporting a larger trolley wire, if desired, than is now commonly used.

The third rail, although used to a considerable extent in place of the trolley, has been criticised, particularly from the standpoint of danger and trouble from sleet. The unprotected rail is open to both these objections, but with a suitable protection against accidental contact and from sleet, these objections are to a great extent overcome. A protection providing these features is shown in the accompanying sketch, Fig. 1, which is similar to the protection in use on the Wilkesbarre & Hazleton Ry., Interborough Subway and the one under construction for the New York Central.

The location of the third rail, with reference to the track, would seem to be a simple question, but owing to local conditions, nearly every installation has been different. Between clearing the low-pressure cylinders of compound locomotives, the hoppers on the large steel coal cars and keeping within the bridge abutments and tunnels, the location is generally a case of compromise. It will be advantageous to facilitate the interchange of equipments by establishing a uniform location of the third rail, and the importance of such a standard and difficulty of finally determining it will increase with every new installation.

The subdivision of the third rail into sections, which will be normally disconnected from the supply circuit and automatically connected when in the immediate vicinity of the car, has many times been proposed. Such an arrangement appears to have little or no advantage, as apart from the complication introduced the sectional third rail should be protected by a covering to the same degree as an ordinary third rail. Unless the sections are very short, the rail will be energized for some distance beyond the car, and persons getting on or off, or working about the car, would be likely to receive shocks, and more especially so as the rail would ordinarily be considered harmless. Another important reason for protecting the rail is that the cover will form a shield from sleet, which is much more troublesome on a sectional third rail than on the ordinary third rail.

The third-rail contact shoe which has been quite generally used depends on gravity for its contact with the rail; therefore, at high speeds with any unevenness on surface of the third rail this type of shoe shows a disposition to jump and arc excessively. A better form of shoe is one in which the contact is held against the third rail by a spring, this principle being applied to the hinged type of third-rail shoes in use on the Interborough Subway and New York Central locomotive. The Boston Elevated Railway was originally equipped with gravity shoes, which have been replaced by others provided with a spring.

AUTOMOTOR CARS.

The initial expense of electrical equipment, more especially that due to the cost of power station and trolley line, has deterred many steam railroads from electrifying branch lines in sparsely populated districts. Such lines could be served more profitably by independent cars than by steam trains, as the possibility of economically operating single cars on frequent headway, by providing a better service, would have an important influence upon the development of the traffic.

To meet the requirements of this class of service, a self-propelled car, independent of any feeder system, seems particularly well suited. With this end in view, there have been numerous schemes suggested and tried, some employing steam and others compressed air as a motive power; again, storage batteries and gasoline engines have been used. Without discussing the relative merits of these different methods, it may be briefly stated that the gasoline engine seems to have the advantage of possessing the greatest power for a given weight, and is also able to cover considerable distances—owing to the concentrated nature of the fuel and the high efficiency of the engine in relatively small sizes. A number of such equipments are in operation abroad, some being provided with a mechanical transmission to the wheels similar to an automobile, and others having a generator direct connected to the engine, with the electric motors mounted on the trucks in the usual way. For cars of the weight commonly used on steam railroads in this country, and those which have bogie trucks, the gasoline-electric combination seems in many respects the better suited.

The principal difficulty that has been experienced with this type of equipment is the insufficient capacity of the engine; and this is not surprising when we appreciate that the motors of a 40-ton electric car under ordinary service conditions are frequently required to develop 500 HP. during acceleration. The building of a successful car of this description is a problem depending entirely upon the engine; and there seems reasonable ground for the belief that an engine well adapted to this class of work can be produced.

The General Electric Co. has under construction an equipment of this character which, if successful, should be well adapted to meet the requirements of the class of service under consideration. This car is provided with passenger, smoking, toilet and baggage compartments, and is 65 ft. long over all. The engine room is at one end and a motorman's compartment is provided at each end of the car, to permit its being operated in both directions. The car complete will weigh, approximately, 55 tons. A general idea of such an equipment may be obtained from Fig. 2, showing plan and elevation of the car body. This print is partially in section to show the arrangement of engine and generator.

The engine will have a full load output of 200 B. HP. and will run at 600 r. p. m. It will be direct connected to a 600-volt generator, the fields of which will be separately excited from an exciter driven by the engine. The controller for the motors will be provided with a series parallel switch, but no starting resistance, in the usual sense, will be required, as the speed of the motors will be regulated by controlling the voltage of the generator through field resistance points in the controller. The water-cooling

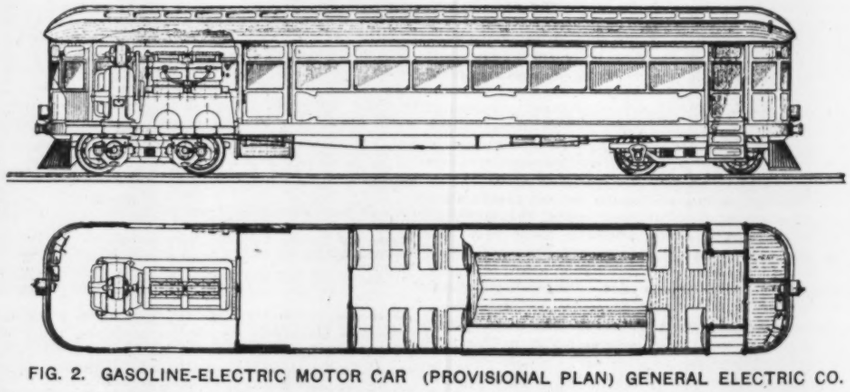


FIG. 2. GASOLINE-ELECTRIC MOTOR CAR (PROVISIONAL PLAN) GENERAL ELECTRIC CO.

system for the engine will be carried through radiators on the top of the car during the summer, and in the winter though the ordinary heater pipes for the purpose of warming the car. An engine of the size proposed will provide for an acceleration sufficient to maintain a schedule speed of 20 to 25 miles where stops are three to four miles apart, and the car can be easily maintained at a running speed of 40 miles. We have no data on which we can accurately base the operating cost of such an equipment, but it seems probable that including all expenses—of the motorman, conductor, fuel and maintenance—the cost will be between 15 to 20 cts. per car-mile. This will depend somewhat on the daily mileage made by the conductor and motorman, as their wages amount to a considerable portion of the total expense. Reference has been made to this type of equipment because considerable interest appears to exist regarding the possibilities in this direction, but what measure of success will be attained can only be determined by a thorough trial. Several different types of engines are under consideration, as is also the use of kerosene as a fuel. The object in view is to produce an equipment comparable in some respects to the all-electric car, and at th same time cheaper to operate than the steam trains, which are usually run over the lines for which an equipment of this type is intended.

DISCUSSION.

W. J. Wilgus.—In the case of the New York Central & Hudson River R. R., which is fitting its terminal portions at New York, for a distance of 20 to 30 miles, for electric traction, the cost of the work required has proved to be several times as great as the cost of simply providing the electrical equipment. In order to enable fullest advantage of the possibilities of electric traction to be obtained, it was necessary to provide for separating local and through traffic, that is, to put down additional tracks. It was also considered absolutely essential that all grade crossings be eliminated on the electric line. New stations will be built, having platforms level with the car platforms, on the rapid transit plan. All this work is thought necessary if the anticipated greater traffic is to be handled properly.

The New York Central has held one opinion contrary to that apparently held by some railways: it believes firmly that its suburban traffic is vital to its best interests, even if this traffic yields no direct profit. Increased suburban traffic means increased tributary population, with resulting increase in freight. The company therefore believes that suburban traffic should be given the best possible service, though the direct returns might not seem to warrant the cost of such service.

Electric traction on the railway's New York terminal division makes possible one thing that has not been possible with steam locomotives: tracks can be placed on several levels, and the terminal capacity thereby increased without horizontal spreading. Further, much of the required terminal switching is either eliminated or simplified by multiple-unit traction, so that the capacity of the terminal will be increased on this account also. Engine houses and their varied and troublesome accessories, such as water plugs, ash pits, etc., will be eliminated. The costly and troublesome work of cleaning the Park Avenue tunnel, work that is now required to be done weekly, will no longer be required when the trains on the terminal division are operated by electricity. These various items of improvement which will result from electric traction add materially to the points of advantage presented in Mr. Potter's paper.

Frank J. Sprague.—After congratulating the General Electric Co. on its new electric locomotive (built for the New York Central), the speaker made the point that the real question is not whether suburban railways or divisions are to be operated electrically, but whether trunk lines will be so operated. This is not, as it is often characterized, merely a question of voltage, or of alternating or direct current, but it is a question of density of traffic. Given a density which makes electric traction economically possible, a system of either high or low tension, direct or alternating supply, may be adapted to the case. On the other hand, there are railways which cannot be electrically operated with success, no matter what tension be used.

High tension does not have the same importance in electric traction as in transmission. In traction work the load on the line is always proportional to the length, and therefore the transmission distance for given loss does not increase as the *square* of the voltage, but only *directly* as the voltage.

The load factor of a railway line is of influence on the practicability of electric traction, besides the *average* density of traffic. However, when the density is above the limits at which electric traction is feasible, the load factor is likely to be satisfactory. In any case, it will affect the operating cost.

B. G. Lamme.—In the electrification of railways which

in the future the question of location of current conductor will early arise as a serious one. Three locations are possible: at the ground level, overhead and underground. The speaker believes that the first location, now very popular, will have to be abandoned. The third rail in a light yard, for example, would be so objectionable that one of the other two locations will need to be adopted. The tendency will probably be toward the overhead conductor, and in consequence also toward higher line voltages than are now considered.

In direct-current traction many sound reasons have led to limiting the voltage to about 600. At this voltage a heavy train would draw at least 2,000 amperes from the wire; to reduce this current to a suitable amount higher voltage becomes necessary. This consideration reduces the problem to single-phase working, using either single-phase motors or a combination of direct-current motors and motor generators on the cars.

Equipment is now being designed for a trolley voltage of 18,000. The Westinghouse Electric & Mfg. Co. of Pittsburg is already building a freight locomotive of 1,500 HP. to work on a 6,000-volt line; its normal speed is to be 10 mi. per hr. This locomotive will apply directly to heavy slow-speed freight service as operated on present-day railways.

The motor-generator system is much less flexible than the single-phase motor system. The former, if suitable for heavy service, is not suited to light lines, such as feeders, whereas the latter system is applicable equally well to both classes of service. The alternating-current system in general has the feature that different voltages can be used on different parts of the line, suiting the voltage to local conditions. Thus, in yards a lower voltage can be used, while on steep grades the trolley wire may carry a higher voltage than the average. With alternating current, also, the power drawn by the car can be varied as desired without making and breaking contacts; this greatly simplifies the control mechanism as compared with that required in direct-current working.

There is no reason to expect much difficulty in the design of the overhead work. Catenary suspension is ideal for the service, and it will meet yard conditions without complication. At East Pittsburg, Pa., a 6,000-volt trolley line 5 mi. long is in successful operation. It has catenary suspension. During a recent snow storm of unusual intensity the line loss on the 5-mi. line was only 1 to 1½ amperes, that is, 6 to 9 KW. On this line a sliding trolley contact is used, but study and experience are needed to show whether sliding or roller collectors are preferable. The wheel trolley will not prove suitable for railway work.

B. J. Arnold.—The third rail is not ideal for the general railway case, but in the New York Central problem it was the only possible answer to the conditions. The elimination of grade crossings, in the speaker's opinion, will be absolutely essential in large scale electric railroading. The question whether direct or alternating current should be used is a vital one (contrary to the belief of Mr. Sprague). There is not a railway in the United States which could afford to equip itself for direct-current traction; but there are many railways which could afford, even to-day, to equip for alternating-current traction. In the special problem of the New York Central terminal work, the decision to adopt direct current was undoubtedly correct two years ago, and in the speaker's opinion it is just as correct to-day.

The problem of "electrifying" main-line railways is one of great importance and great difficulty. The speaker acknowledged that he never rides behind a steam locomotive without being forcibly impressed with this fact. Passenger service, it may be expected, will be the first to come under electric operation, but it is likely that later freight traffic will follow, even if for this service electric operation should prove to be no cheaper than steam. It is reasonably certain even to-day that with proper density of traffic, freight service can be operated as cheaply by electricity as by steam; but even where electric operation should not show economy for freight service, considerations of convenience and simplicity will lead to ultimately extending electric operation from passenger to freight service on all important railways.

George Gibbs.—The conductor problem has been a matter of great interest to the speaker, because it has seemed to him one of the most important problems in the general question of electric operation of large railways. A study of the various forms of third-rail and overhead trolley has led him to conclude that the latter is out of the question; the necessity of supplying very large currents is one of the reasons leading to this conclusion. If the third rail will be generally used, its standardization is of the utmost importance at the very beginning of main-line electric working. Three years ago the speaker brought this subject before the Master Car Builders' Association, with the suggestion that steps be taken to limit the extension of locomotive cylinders, coal-car hoppers, etc., into the clearance space. The possible distance of third rail from the gage line is limited by bridge and tunnel clearances, and its height is determined within small limits by the insulator consideration. Yet some of the rolling stock of to-day extends to within 1 in. of the extreme possible standard location of third rail. The Association has up to the present failed to take action in the matter, but it is certain that the question must receive most serious consideration in the near future.

J. G. White.—The matter of capital account has been omitted from the discussion given in Mr. Potter's paper. It is exceedingly important, in general discussion as well as in considering a special case, to balance the advantages and disadvantages of electric and steam operation in terms of money. Another matter which should be given more emphasis is the very great increase of traffic which has been observed in nearly all cases of electric railways paralleling steam railways between important centers. The multiplication of total traffic in these cases is anywhere from two or three times to 80 times, and in nearly all cases the parallel steam traffic has decreased.

The bow (sliding) trolley has recently had an absolute failure recorded against it. An electric railway built in Holland between two cities some distance apart was equipped with bow trolleys of a type and construction which had proved successful in city work. Under the higher speeds of this interurban line, however, they failed absolutely, for with only 15% of the cars in service the entire stock of trolleys was used up, and operation was almost broken up until wheel trolleys were substituted.

DATA ON ROADS AND PAVEMENTS IN IOWA.*

PAVEMENTS.

During the last three years there has been a marked revival of paving in Iowa following the almost total cessation of such work caused by the decisions of the Supreme Court of the United States which cast doubt upon the constitutionality of our old paving law. Since these decisions, however, our State Legislature has amended our assessment laws to conform with the decisions. Since the resumption of paving in this state during the last three years the most interesting developments have been the narrowing of the paved width of our streets, the extension of paving to small cities, and the contest which has been waged in many places in our state between the advocates of brick and asphalt paving.

Fig. 1. Macadam Road, Cedar Rapids to Marion, Ia. (Tractive resistance, 46 lbs. per ton.)

Fig. 2. Earth Road, Near Road in Fig. 1. (Tractive resistance, 383 lbs. per ton.)

In the line of relative tractive resistance on brick and asphalt pavements few tests have yet been made. On this account the results of some tests by the Civil Engineering Department of the Iowa State College may be of interest.

These tests were all made with ordinary draft wagons. For the tests at Des Moines the diameters of the wheels were 36 ins. and 52 ins., and the width of tire was 1¼ ins. For the tests at Cedar Rapids the diameters of wheels were 44 ins. and 52 ins., and the width of tires was 1½ ins. For the tests at Pittsburg the diameters of the wheels were 42 ins. and 54 ins., and the width of the front tires was 3 ins. and that of the rear tires 3½ ins. In all tests the grade resistance was eliminated, so the results gave the tractive resistance on a level grade.

The tests at Des Moines were made by Messrs. F. McClure and A. B. Chattin, those at Pittsburg were made by Mr. A. B. Chattin, and those at Cedar Rapids were made by Messrs. T. H. MacDonald and L. T. Gaylord, all students of the Civil Engineering Department at Ames.

These tests confirm the conclusion reached by Professor I. O. Baker that the tractive resistance on asphalt increases rapidly as the temperature increases. They indicate that in the summer months the tractive resistance on a smooth asphalt pavement may at times be much larger than on a brick pavement.

A very remarkable feature of the work in paving in Iowa during the past few years has been the extension of paving to small towns. The present indications are that within a short time most towns of 2,000 or more population will consider some amount of paving a necessity.

Besides reducing the thickness of concrete foundations, another means of cheapening pavements on residence streets and in small towns is that of diminishing the width to be paved. Not only is the first cost cheapened but the appearance of residence streets is very much improved by having wide, neatly kept parking on each side of the street. Many towns which do not consider it possible to pave their streets are grading them and putting in cement curbs. In such cases also the wide parking and narrow distance between curbs should be adopted; 24 to 30 ft. is sufficient.

ROADS.

The country roads of Iowa, like those of the surrounding states, are notoriously bad. During the recent wet seasons they have been in especially bad condition.

It really seems absurd that in a state so wealthy and prosperous as ours, so advanced as regards the education and intelligence of the people, the entire business of the agricultural community, which in Iowa is the basis of practically all business interests, should be left to the mercy of bad weather on account of roads which would

*Abstract of the report of the Committee on Roads and Pavements, presented by Prof. A. Marston, Chairman, at the annual meeting of the Iowa Engineering Society.

TRACTION TESTS ON BRICK AND ASPHALT PAVEMENTS.
Made by the Civil Engineering Department of the Iowa State College, Ames, Iowa.

Date.	Place.	Character of Pavements.	Tractive resistance, lbs. per ton.	Temperature.
		Brick Pavement.		
1903. Apr. 15.	Des Moines.	One course, sand-filled, much-worn and broken	68	35° F.
Apr. 15.	" "	On concrete, sand-filled, much-worn and rough	43.3	35
Apr. 15.	" "	Same as above	37.6	35
Apr. 15.	" "	On concrete, sand-filled, dirty, well worn	33.3	35
Apr. 15.	" "	On concrete, nearly new, cement-filled	31.7	35
Apr. 15.	" "	On sand, sand-filled, condition fair	29.1	35
Sept. 5.	Pittsburg, Pa.	New, sand-filled	37.2	70
Sept. 5.	"	Old, tar filled, smooth clean:	28.2	75
Sept. 5.	"	Old, cement-filled, clean, smooth	25.4	75
1904. Mar. —	Cedar Rapids.	Clean	16.0	about 60°
Mar. —	"	Dirty	19.0	about 60°
		Asphalt Pavement.		
1903. Apr. 15.	Des Moines.	New, quite dirty	26.7	35° F.
Apr. 15.	" "	New, clean, smooth	24.9	35
Apr. 15.	" "	New, clean, smooth	23.3	35
Sept. 5.	Pittsburg, Pa.	Old, clean, much used	29.1	66
Sept. 5.	"	New, clean, little used	24.2	69
Sept. 25.	"	Old, dirty, little used	39.9	69
Sept. 26.	"	Old, clean, very little used, pitted	67.8	82
Nov. 6.	"	Same as above, but colder	36.5	31
Dec. 7.	"	Same as above after period of cold weather, dirty	34.4	20
Sept. 26.	"	Clean, new, very little used	55.5	82
Nov. 6.	"	Same as above, but colder	31.1	30
Dec. 7.	"	Same as above after period of cold weather, fairly clean	25.5	20
Nov. 6.	"	Block asphalt, one year old, much used, worn, clean	28	38
1904. Mar. —.	Cedar Rapids.	Clean	34	about 60°

be a disgrace even to barbarism. Every business interest in our state would be benefited by making our roads reliable at all times and seasons. We talk of improving our country schools by centralizing them, but this will not be possible until the roads are made passable at all times. Even the recent advantages secured by the extension of rural free mail delivery and endangered by the periodical relapse of our roads into impassable conditions, and we have seen in the last few years these advantages retained in many cases only by the voluntary efforts of private citizens to improve the road conditions.

THE NEW IOWA STATE HIGHWAY COMMISSION.—The good roads problem in Iowa has been brought especially to the attention of the chairman of your committee on roads and pavements during the last year by a law passed by the last legislature creating a State Highway Commission. This law provides that the Iowa State College of Agriculture and Mechanical Arts, at Ames, shall act as a highway commission for Iowa.

The trustees of the college assigned the work of this State Highway Commission jointly to the two Deans of the Divisions of Engineering and Agriculture. Some work in this line had been in progress in the engineering division for some years before the passage of the act, and its results became immediately available. Funds for carrying out the act became available July 1, 1904.

Mr. T. H. MacDonald has been engaged to take especial charge of this work and is now engaged in it.

A GENERAL SURVEY OF THE GOOD ROADS PROBLEM IN IOWA.—A few of the general facts bearing on the good roads problem in Iowa which have been developed in the work of the highway commission may be of interest. There are approximately 100,000 miles of country roads in our state. So far as our study has gone, we estimate that about 25% or 25,000 miles of these roads ought to be classed as main traveled roads, which should be, as rapidly as feasible, made hard roads, thoroughly reliable at all seasons and during all weather conditions. With this 25% of the roads thus improved, no farmer would be much further than two miles from an improved road running north and south and another running east and west, and, of course, the great majority of the population would be much closer to such improved roads. Only about 1,000 of these 25,000 miles have already been gravelled or macadamized.

TRAFFIC ON IOWA HIGHWAYS.—In investigating the traffic over our country roads, house to house canvasses have been made in a few typical townships located in different parts of the state, blanks being filled out for each farm showing the amount of hauling over the roads and the cost of the same, and the amount of other traffic over the roads. In these townships we find on the average that, on a basis of $2.50 per day for man and team, the cost of heavy hauling was about 40 cts. per acre per annum, and the cost per ton-mile about 24 cts. Of course estimates based on these few townships of the total traffic of the state are not reliable, but as no other data are available for such estimates, we may say that if the averages for these townships held true for the entire state the heavy traffic over the country roads of Iowa would amount to about 55,000,000 ton-miles per annum, and the other travel to about 350,000,000 miles per annum.

Realizing that estimates based on the limited data at hand are not reliable, the State Highway Commission has secured the insertion in the census questions for the census which Iowa is conducting in 1905 of an agricultural road schedule. (This schedule was printed in our issue of Jan. 19, p. 70.—Ed.)

We believe that when the data from these questions have been collected and collated we will have more extensive and reliable information on the traffic over country roads than any other state has attempted to procure.

RELATION OF PRICES FOR AGRICULTURAL PRODUCE TO CONDITION OF HIGHWAYS.—A line of investigation which is somewhat related to the above is the relation of prices of agricultural produce to the condition of the country roads. While one of the stock arguments in favor of good roads has been the statement that bad roads prevent the farmer from securing the benefit of high prices, yet nothing in the way of actual statistics has heretofore been secured to bear out the statement.

In the accompanying diagram (not reproduced.—Ed.) it is shown that the highest prices (in Woodbury County) for oats, corn and hogs, occurred at a time that the roads were practically impassable.

PRESENT ROAD FUNDS AND EXPENDITURES IN IOWA.—Under the present road law, according to the best information which we now have available, about $2,250,000 road taxes per annum are collected and expended upon the country roads of the state. The maximum road tax is five mills, of which four mills is levied and expended by the township trustees and one mill by the county supervisors. In some counties additional funds are provided from other sources. The above-mentioned funds do not include the money raised for bridge purposes, the ordinary maximum amount of which is three mills. Presumably then somewhat less than $1,400,000 are raised per annum for bridge purposes, and the law permits any excess in this fund to be expended on the roads. Altogether it is probable that from $3,500,000 to $4,500,000 per annum, or about $30 to $40 per mile, are raised and expended on the country roads of Iowa. Under present conditions the people of this state are not securing the proper returns for the money expended, owing to the fact that the roads are not put into the hands of skilled experts.

ROAD MATERIALS AND METHODS FOR IOWA.—The macadamized roads of the East have cost from $5,000 to $10,000 or more per mile. If the average be estimated at $8,000, the corresponding treatment of the 25,000 miles of main travelled roads in this state would call for an expenditure of at least $200,000,000, and it is certain that the actual cost would be higher because we do not have close at hand in our state the necessary road materials. Conditions in Iowa are very different from those in the eastern states where state aid laws have been made use of for the construction of expensive systems of macadamized roads. For example, in Massachusetts the Chairman of the State Highway Commission informed the writer that 67% of the population is concentrated in cities of over 12,000 population. In Iowa, on the other hand, not more than 15% live in such cities. With 2,805,000 population, Massachusetts has only about 20,000 miles of country road, while Iowa, with only 2,232,000 population, has about 100,000 miles. Obviously much more expensive methods can be used to improve the roads of Massachusetts than would be found possible at present in our own state. We must adopt, for the present, much less expensive methods of construction in this state as a rule.

As examples of what can be done in Iowa, may be mentioned the macadamized road from Cedar Rapids to Marion which is said to have cost about $3,000 per mile, and the gravel roads of Greene and Carroll counties in which the gravelling alone cost only about $400 per mile. The grading and gravelling of roads in Carroll county are said to cost about $700 per mile.

The most suitable local materials available for the improvement of our Iowa roads are broken limestone and gravel. The only objection to the limestone road, when properly made, is the fact that the stones wear rapidly so as to produce a very fine white dust which is extremely objectionable. In the East the writer found that in some states attempts were being made to maintain the macadamized roads by the use of cementing gravel as a surfacing material, and in northern Illinois some successful experience is reported in the use of gravel as a surfacing coat on a broken limestone foundation.

The trouble with the gravels of our state in many cases is that they do not naturally contain a satisfactory amount of binding material. The gravel with which such successful results have been secured in New Jersey naturally contains a very satisfactory binder. The Iowa Highway Commission is now experimenting with the artificial mixing of clay with our Iowa gravels to make them bind.

MUNICIPAL ENGINEERING WORK IN NEW YORK CITY IN 1904.*

By Nelson P. Lewis,† M. Am. Soc. C. E.

Recognition of the engineering profession has never been more freely given in municipal government than during the past year. The Mayor of this city, in announcing his policy as to the future water supply for the municipality, has made it clear that the commission which shall be charged with the responsibility of expending the vast sums required for that work shall be an engineering commission. This is not an isolated example of such a policy, for he has invariably shown a disposition to recognize the value of technical advice. Late in 1903 the Board of Aldermen authorized the creation of a commission to consider and report upon a comprehensive plan for the development of the city, a plan which should take account of the enormous increase in population and business now taking place and which will follow closely upon the extension of the Rapid Transit system and the improvements in progress by transportation companies. This commission was named by the present Mayor, and includes the Chief Engineers of the Department of Bridges, the Department of Docks and Ferries, the Board of Estimate and Apportionment, and the Landscape Architect of the Department of Parks. I venture to say that the inclusion of these engineers in a commission of this kind would not have been thought of a few years ago. The commission has submitted a preliminary report outlining various plans which it has had under consideration, but making no specific recommendations. A further report will be made during the present year.

An evidence lately given us that public service corporations are manifesting a willingness to voluntarily assume large expense for improvements which neither the city nor the state could compel them to undertake is the recent action of the New York, New Haven & Hartford R. R. Co. in planning to convert its Harlem River Branch into a modern six-track, electrically operated railroad, and to eliminate every grade crossing along its line within the limits of the city. The situation has been a peculiar one. Many of the streets crossing this line did so at grade. To carry them over or under the railroad would have involved the depression or elevation of their tracks, as well as the raising or lowering of the streets. Numerous complaints of these dangerous crossings had been received, and it was realized that the impossibility of carrying additional streets across the tracks was retarding the development of the adjacent territory. Had the city taken the initiative in their elimination, it could have proceeded only under the existing grade crossing law, under the provisions of which the city would have been obliged to bear one-half of the expense. As the readjustment of the railroad grades on both sides of a crossing is held by the Railroad Commission to be an expense which must thus be shared by the company and the municipality, and as the crossings were not far distant from each other, the city would have been obliged to pay half of the expense of the entire change in the railroad grades, which would have been enormously expensive. In the proposition of the New York, New Haven & Hartford R. R. Co., consent was asked for the discontinuance of a short portion of one street, for slight changes in the grades of several other streets (the changes being in all but one case limited to a few inches), and the railroad company offered to pay the entire expense, not only of the changes of its track grades, but also of the building of the bridges over all existing streets and such other streets as may hereafter be opened, and to pay all damages for the closing of the street above mentioned, to which the courts may determine the property owners affected to be entitled.

The combination of companies which control the lighting of the public streets, parks, buildings, etc., have not been governed by so wise and liberal a policy. Having an absolute monopoly of this business, they have endeavored to exact such terms that the city has been obliged to consider the building of a plant to do its own lighting, and a commission of three has been appointed to prepare general plans, specifications and estimates for such a plant, and although it is held that the city already has power under its present charter to embark in such an enterprise, legislation is asked for which will render this right unquestionable and prevent interference with the work by a so-called taxpayers' action.

I do not propose to discuss the wisdom or folly of municipal ownership or operation, or both, of the various public utilities. These questions will be determined by publicists and by an intelligent public opinion. This city has already made its first venture in a conservative degree of municipal ownership by the construction of our Rapid Transit Railroad, and if public opinion is correctly interpreted by the press, it is desired that, in future extensions, the public control shall be rendered more direct by building first, and leasing afterward, under contracts running for much shorter terms than those granted the contractor for the sections now in operation or under construction.

Reference was made a year ago to the triangulation of the city of New York under a plan of cooperation between the city and the United States Coast and Geodetic Survey. This work has been in progress during the past year, and very satisfactory results have been attained, notwithstanding the great difficulty attending the making of observations in a great manufacturing city. These difficulties are forcibly shown by a statement of the number of days of each month during which observations could be made. In 1903 they were as follows:

August 6, September 11, October 5, November 9, December 3.

During the year just passed the record is about the same, namely:

January 5, February 8, March 9, April 9, May 12, June 16, July 11, October 6, November 6, December 3.

During the month of August no observations were made, as the parties took their vacations during this month, one-half during the first two weeks, and the other half during the remaining two weeks. In September, the entire force was occupied in laying out, staking and measuring the Ocean Parkway base. The Coast and Geodetic Survey has given every assistance possible to the city in the prosecution of its work, having placed at the disposal of the party the observing theodolites, heliotropes and some other instruments needed on the work. Most of the observations were made with a 10-in. repeating theodolite, made by Gambey, of Paris, some thirty or forty years ago, but which had been regraduated by the Coast and Geodetic Survey. It has steel spindles, and is read by two verniers to five seconds. The telescope has an objective of 2 ins. clear aperture. Another instrument of the same make and size was furnished, but it was found more difficult to use with good results by one not accustomed to it. We were also furnished with a 6-in. theodolite recently made in the instrument division of the Coast and Geodetic Survey. This instrument has glass hardened spindles, and the telescope tube and the upper works are of aluminum. The axis extends below the leveling screws and stand, while the stand and the outer covering of the axis is of bronze. This method of construction lowers the center of gravity and increases the stability of the instrument, while the light upper portion reduces the friction on the centers to a minimum. It is read by two verniers to ten seconds. The points from the platforms of the observing towers were transferred to monuments beneath by a vertical collimator, also fur-

*Extracts from Presidential address at the annual meeting of the Municipal Engineers of the City of New York, Feb. 1, 1905.

†Chief Engineer, Board of Estimate and Apportionment, City Hall, New York City.

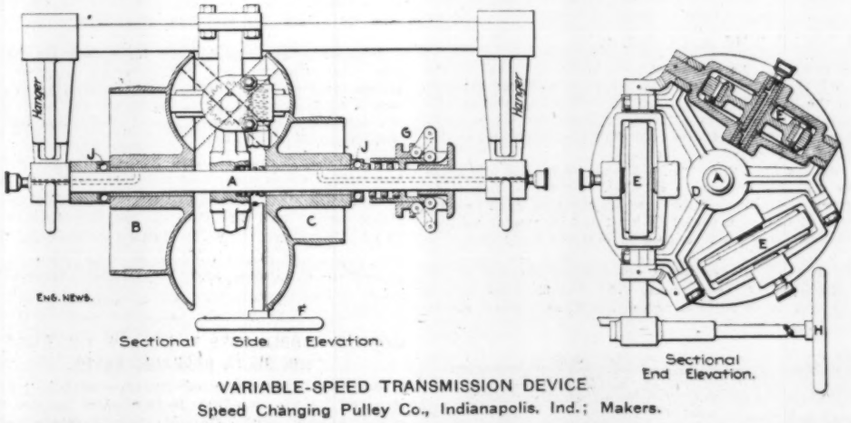
hed by the Survey. This is a short telescope with ss-hairs in its diaphragm, mounted vertically, with a y delicate level. The observer looking down the tele- pe can fix the point on the bolt set in the monument ectly beneath the telescope, while transferring a point observation from a platform 70 ft. or more in height the usual mechanical methods is exceedingly difficult. In striving to look forward to the New York City of the ture I fancy I can see the greatest city of the world, great- not only in area, population and wealth, but in those tributes which go to make up the truly great metropolis greatest in her public buildings, in her temples conse- rated to religion, music and the drama, in her institu- ions of learning, in her provision for amusement and ecreation, in her zealous and efficient care for the public ealth, in the wisdom shown in her public and private harities for the care of the unfortunate and helpless, and in the justice combined with mercy shown in her treat- ment of vice and crime. I see a great city welded into a homogeneous whole by easy, rapid and ample facilities for transportation, enabling the residents of each portion to reach any other portion with comfort and speed, and where provincialism has given way to a broad metropoli- tan spirit; where great public works are undertaken, not in response to ill-considered and hysterical public clamor, but in conformity with carefully considered plans made after mature study by experts in the permanent service of the city, and which will not be changed at the caprice of those holding office for brief periods. In their execu- tion a policy of broad liberality, without extravagance, and economy free from niggardliness will prevail.

You ask me what potent influence will result in the creation of such conditions and produce an enlightened public sentiment which will demand them? My answer is a simple one: If the municipal engineers of the city of New York will live up to the highest standards of their profession; if they will demonstrate their efficiency and devotion to the highest ideals; if they will serve the city with singleness of purpose, and give to it the best that is in them, not stopping to consider whether they are giving in effective work more than they are receiving as com- pensation, the public will soon learn to believe in them, will rely upon their judgment, and will demand that the control of our public works shall be placed more and more completely in their hands. When this shall have been done, I am optimistic enough to believe that the conditions I have endeavored to describe will result.

VARIABLE SPEED DEVICE FOR MACHINE TOOLS.

The machinery exhibits at the St. Louis exhibition included several speed-varying mechanisms for application to machine tools, printing presses and other classes of machinery, and among these was the device illustrated herewith. It was applied to an 18-in. crank shaping machine driven by a 2-HP. electric motor, and had a speed variation of 8 to 1. It was mounted on the frame of the machine.

This device, as mounted independently of the machine, is shown in the accompanying cut. The



VARIABLE-SPEED TRANSMISSION DEVICE
Speed Changing Pulley Co., Indianapolis, Ind.; Makers.

hangers carry a shaft A, which does not revolve, and upon which are mounted the belt pulleys B and C, the former being belted to a motor or a line shaft, while the latter is belted to the machine. Between these pulleys hangs a stationary frame, D, carrying three transmission wheels, E, whose rims ride on the curved or troughed flanges of the belt wheels. By means of gearing operated from the hand wheel, F, the transmission wheels can be set parallel with or at any angle to the shaft. When parallel with it, as shown by the full lines, they ride on equal diameters of the flanges of the two belt pulleys, and consequently the driven pulley, C, runs at the same speed as the driving pulley B. If the transmission wheels are shifted to the position shown by the dash lines, the pulley C will be driven at its maximum speed; while if they are shifted to the position shown by the dotted lines, it will be driven at its lowest speed. There are no tight or loose pulleys, but a spring clutch, G, is connected to the hub or sleeve of the pulley C, and operated by the wheel H. By this clutch the pulley may be held still or allowed to revolve upon the shaft. The thrust is taken by ball bearings, J.

This device, which is adapted to various classes of machinery, is manufactured by the Speed Changing Pulley Co., 750 East Washington St., Indianapolis, Ind.

COPPER SULPHATE AND COPPER FOIL OR COPPER VESSELS FOR THE TREATMENT OF TYPHOID-INFECTED WATER.

The use of copper sulphate and of copper foil to purify water containing typhoid or other dangerous germs is discussed in the "American Journal of Pharmacy" (Philadelphia) for December by Dr. George T. Moore, of the U. S. Department of Agriculture, and by Prof. Henry Kraemer, Editor of the journal named. It may be remembered that Dr. Moore's bulletin on copper sulphate as a means of preventing algae growths in reservoirs (see Engineering News, May 26, 1904) contained a reference to the possibilities of copper for the sterilization of water. In his present discussion of the subject Dr. Moore says:

> It should be stated most emphatically and clearly understood that it was not supposed for a moment that such a method could be substituted for efficient sand filtration or any other means now in use which has been demonstrated as doing the work thoroughly. It was believed, however, and practical tests since made have proved it, that in cases where no system of filtration existed, or where the filter failed, owing to the storage basin being flooded by surface drainage, or because of leakage or other cause, this method was not efficient, that in copper sulphate we had the only remedy for such emergency cases. * * * * * Consequently the application of copper sulphate under such circumstances for the purposes of reducing the bacteriological content has been successfully used in enough cases to demonstrate that it has a distinct place in water purification. So far as I know, its use has been resorted to for but a short time, or until the source of pollution could be removed. Whether it would be efficient and proper to use it continuously during a considerable period awaiting the completion of a filtration system is a question to be decided by the conditions governing the case.
>
> * * * * * *
>
> In one case where copper was used for the purpose of destroying the algae, the bacteria were reduced 95%, and while sewage bacteria were found before treatment, they disappeared entirely afterwards. In another case where a large storage reservoir was flooded, owing to the breaking of a levee, the bacteria were reduced from 5,000 cu. cm. to less than 50 per cu. cm. Again, in the case of a spring which was accidentally polluted, and which gave rise to over fifty cases of typhoid in less than a week, the use of copper completely sterilized the water, and it was possible to continue using the spring within five hours.

One part of copper sulphate per 100,000 parts of water, it is said, will destroy typhoid and cholera organisms in three to four hours. This statement is found in Professor Kraemer's article, already mentioned, and Dr. Moore is cited as authority for it.

After giving evidence to show that copper is not harmful to human beings, Professor Kraemer describes some experiments of his own on copper sulphates as a germicide. Samples of tap water, kept at room temperature for 48 hours, showed a 99% reduction of all micro-organisms when dosed with 1 part of copper sulphate per 100,000, and of 90% when the dose was but 1 part per 1,000,000. In other and more extended experiments still in progress, copper foil is being used instead of copper sulphate. Ordinary thin sheet copper, placed in vessels of water, reduced the total number of bacteria by 85 to 97%. It was assumed "that if any typhoid and colon organisms were present they would have been among the first to be destroyed." Later experiments with pure cultures of typhoid and of colon bacilli, placed in water with copper foil, showed a complete destruction of those germs after four hours' exposure, while control tests in water containing no copper showed the presence of the germs to the end of the observations, which extended through two days for the coli and five days for the typhoid germs. In each series ordinary tap water, filtered tap water and triple distilled water was used.

From these laboratory experiments Professor Kraemer concludes that copper foil placed in water containing colon and typhoid bacteria will completely destroy those germs; that both copper foil and copper sulphate have an effect on drinking water "in a quantitative sense much like filtration, only the organisms are completely destroyed"; and finally that:

> Pending the introduction of the copper treatment of water on a large scale the householder may avail himself of a method for the purification of drinking water by the use of copper foil about 3½ ins. square to each quart of water, this being allowed to stand over night, or from six to eight hours, at the ordinary temperature, and then drawn off or the copper removed.

Professor Kraemer did not use copper vessels in his experiments because all such vessels on the market are tin-lined. This fact, we may add, is an interesting comment on popular American ideas as to the dangers of using water which has been in direct contact with copper. The people of some other countries, we understand, use copper water vessels by choice, and this fact has been advanced as an argument in favor of not only the harmlessness but also the value of storing water in copper vessels.

Brief comment on the use of copper as a germicide may be found in our editorial columns this week.

A GREAT ERUPTION from the volcano of Momotombo, in Nicaragua, is reported to have begun on Jan. 16. The mountain is situated on the northwest shore of Lake Managua, some 90 miles distant from the route proposed for the Nicaragua Ship Canal. Momotombo is about 6,000 ft. in height and has been practically extinct for many years. It was referred to by the Nicaragua Canal Commission of 1895 in its report as "still giving evidence of a moribund vitality."

PROPAGATING THE YELLOW LOCUST FOR RAILWAY TIES.

The advantages of yellow locust timber to resist decay, are referred to in an article elsewhere in this issue, describing its use for waste-gates in the construction of a small dam. At the Forestry Congress, held at Washington last month, Mr. Jos. T. Richards, Chief Engineer of Maintenance of Way of the Pennsylvania R. R. Co., described the work undertaken by that company in the propagation of the same timber for railway ties. We print the following extract from his paper:

> Within the past two years we have begun the planting of the yellow locust trees on an extensive scale, on property owned by the company. The trees thus planted are seedlings two or three years old, and cost, including labor of planting, about 8 cts. each. Generally speaking, these are planted 10 ft. apart, thus averaging about 400 to the acre, although in the fall of 1904 we planted 54,871 trees 6 ft. apart, and 88,127 trees 8 ft. apart. The total quantity planted to date is 280,530.
>
> During the coming year we expect to plant about 800,000 trees additional—say, 200,000 in the spring and 600,000 in the fall.
>
> There is probably no other timber which combines so well the qualities of durability and hardness as does the yellow locust. Evidences of their longevity in use as tie timber are frequent on our road. The resistance of locust timber to cutting under the rail is said to exceed that of white oak, and it has been demonstrated upon our lines that for our main tracks it is not so much the decay of the timber as it is the cutting in by the rail which wears out or decreases the life of the tie. The average life of a strictly white oak tie is about ten years. We expect to get additional life out of a locust.

The main attention which this class of timber seems to require during growth is that of pruning the lower branches of the young trees, plowing and harrowing the ground in which they are planted, and keeping the weeds down, as far as possible.

While it is not likely that the railroad company will at any time undertake to plant a sufficient number of trees from which to secure its entire supply of cross ties, we feel that the experiment made by the railroad of raising its own tie timber will have a tendency to stimulate outside parties, who are small owners of property, to cultivate this class of timber, and in this way assist the railroad company, in the vicinity in which they are located, by furnishing cross ties at some future time.

In order to supply our entire needs for the year, namely, 3,000,000 for repairs and 500,000 for new work, and adding thereto 10% for the immediate future increase, making the total annual requirements 3,850,000 ties, we figure that three ties to a tree would require about 1,300,000 trees each year to produce the probable number of ties needed, and to produce the necessary number of trees available for tie cutting each year, so as to produce the 3,850,000 ties, figuring that it will require twenty-five years for a yellow locust tree to mature, would require a continuous growth of 39,000,000 trees, 1,300,000 to be planted each year, which, if planted 10 ft. apart or about 400 trees to the acre, would entail the continuous use of 97,500 acres, or 152 square miles, of ground for the purpose.

THE LAGUNA DAM, YUMA IRRIGATION PROJECT, CALIFORNIA.

The Reclamation Service of the U. S. Geological Survey is now asking bids on a rock-fill dam, with concrete and sheet pile cut-off walls, to be built across the Colorado River at a point about ten miles northeast of Yuma, Arizona. The great length of the dam, nearly a mile, and the fact that it is to be founded directly on sand and gravel, make it an exceedingly interesting structure. Although it has a maximum height of only 19 ft., exclusive of the sheet piling, it has a maximum base width of nearly 250 ft. The design is such as to cause water that seeps under the cut-off walls to exhaust its energy by the long distance travelled through the interstices of the sand and gravel.

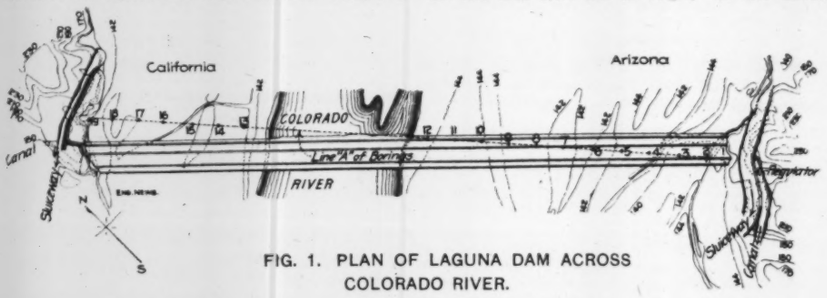


FIG. 1. PLAN OF LAGUNA DAM ACROSS COLORADO RIVER.

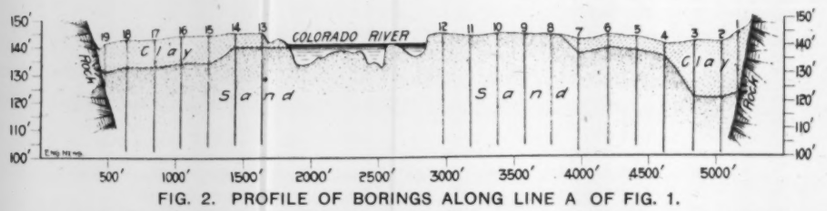


FIG. 2. PROFILE OF BORINGS ALONG LINE A OF FIG. 1.

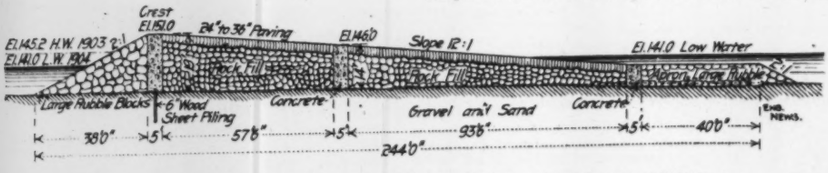


FIG. 3. MAXIMUM SECTION OF LAGUNA DAM ON LINE C-D OF FIG. 1.

As shown in Fig. 1, there are to be sluiceways cut in the solid rock at each end of the dam. Some concrete will be used in these sluiceways, although the greater part of the concrete work will be in the cut-off walls shown in Fig. 3. The approximate quantities of the different items are as follows:

282,000 cu. yds. earth excavation.
305,000 " " rock excavation.
305,000 " " rock placed in dam.
27,150 " " concrete.
80,000 sq. " paving.
53,000 lin. ft. sheet piling.

The bids for this work are to be opened Mar. 15, 1905, and the work must be completed within two years after signing the contract.

The specifications for the rock-fill and the sheet pile cut-off contain features of interest, and are given in full as follows:

ROCK-FILL.

Sizes and Shapes of Rock.—The rock used may be as irregular in shape and size as the run of the quarry. At least two-thirds of the total quantity shall consist of blocks not less than 1,000 lbs. in weight. Of this amount at least one-half must consist of blocks not less than 4,000 lbs. in weight. The balance may be small stones and chips. The lower portion of the rock-fill shall contain the largest stones which can be handled economically from the quarry.

All of the rock taken from the sluiceways shall, when suitable, as specified above, be deposited in the dam. It shall be measured in excavation, and paid for at the price bid for rock excavation. Any rock taken from the sluiceways which is not suitable for placing in the dam will be paid for at the same price, but shall be wasted where directed by the engineer within a distance of 1,000 ft. from the adjacent abutment of the dam. No payment will be made for haul. The waste piles shall be measured monthly, and the difference between the total amount of excavation in the sluiceways and the estimated number of cubic yards of solid rock in the waste piles shall be paid for at the additional price bid for placing the material in the dam, whether placed in the rock-fill, paving or concrete. An additional price will be paid per square yard for the pavement, and per cubic yard for concrete in the dam to that paid for excavating and placing the rock in the dam. In estimating the quantity in the waste piles 1¼ cu. yds. of loose rock shall be taken as the equivalent of 1 cu. yd. of solid rock.

Placing Rock-Fill.—The rock shall be dumped into place by dropping it from an elevation of not less than 5 ft., except near concrete walls, where the rock must be lowered into place or placed by hand and thoroughly packed. Especial care must be used in order to avoid injury to the walls, and in case they are injured the contractor shall repair all damage at his own expense and to the satisfaction of the engineer. The rock-fill must form a compact mass without large interstices. Small stones and chips must be dumped, or thrown by hand, into the open spaces between the large rubble stones. The slopes of the finished rock-fill and rubble pavement must conform to those designated on the plans. Before laying the pavement the upper surface of the rock-fill shall be carefully leveled off, the cavities being filled with stones of suitable size in order that the pavement may be properly laid thereon. The largest rubble blocks which the quarry will supply and which can be handled economically shall be used in the apron. No stone in the apron shall project more than 1½ ft. above the upper surface, as shown on the plans. No part of the rock-fill within 4 ft. of the surface of the dam shall be laid under water excepting the apron and upper slope.

Price Bid.—The price bid for placing rock in the dam shall cover all incidental expenses incurred, such as for material, plant, labor, tools, protective works, and pumps, transporting and placing the rock, as hereinbefore specified.

PAVEMENT.

Sizes and Shapes of Rock.—All paving blocks shall be roughly rectangular in shape, and in size must conform to the following standards: The length of any block shall not be less than 2 ft., and at least 10% of the entire lot shall be 3 ft. long. The breadth shall not be less than 1 ft. nor the thickness less than ½ ft.

Placing Pavement.—The rubble paving blocks must be set on end and packed together as closely as possible. Each paving block shall be tamped until it rests firmly upon the rock-fill. No stone shall project more than 3 ins. above, nor be depressed more than 3 ins. below, the surface of the slope, as shown on the plans and established by the engineer. The voids between the paving blocks shall be tightly packed with spawls and quarry chips, which must be tightly driven into place with suitable tamping bars or hammers, the object being to wedge and key the whole together from wall to wall, in order that the blocks shall not be displaced by the water flowing over the dam. No portion of the rubble pavement shall be laid under water.

Price Bid.—The price bid per square yard for laying the rubble pavement shall cover all incidental expenses incurred for plant, labor, tools, protective works, and pumps used in placing and securing the rubble pavement, as hereinbefore specified.

SHEET-PILING.

Description.—The permanent sheet-piling shall be built up of three 2 × 12-in. Oregon pine planks, as shown on the detailed drawings. Each sheet pile must be thoroughly spiked and clinched by at least one spike per square foot. All spikes to be of wrought iron, 7 ins. long and ⅝-in. in diameter. To make the sheet piles drive tight together, each pile shall be sharpened obliquely, as shown on the drawings.

Method of Driving.—Sheet piles may be driven by any approved form of pile driver, or preferably, by the "hydraulic jet" method, which shall be used when so ordered by the engineer. If they are driven by this latter method, they shall be constantly loaded with the weight of a 2,000-lb. hammer. They must be driven vertically and along the center line of the crest wall. In case any pile spreads, breaks, or does not drive in close contact with the adjacent pile, it must be pulled, and it or other piles shall be driven until a satisfactory junction with the adjacent pile is secured. All sheet piles shall be driven to a depth of at least 10 ft. below the bottom of the crest wall unless bed rock or hard bottom is struck at a less depth. All sheet piles, when driven to the requisite depth, shall be cut off at an elevation of 1 ft. above the bottom of the crest wall. The necessary length of sheet piles shall be ascertained by driving test piles at the localities where they are to be used. If, in the opinion of the engineer, longer piles than those shown on the drawings are needed, the contractor shall furnish and drive such piles.

Price Bid.—The price bid per linear foot for permanent sheet-piling in place shall cover all incidental expenses incurred, such as for material, plant, tools, protective works or pumping, transportation, and labor. Only the actual number of linear feet of sheet-piling left below the cut-off will be paid for.

As many of our readers know, this project is but one of many now under consideration for the reclamation of arid lands in the United States, all being under the direction of Mr. F. H. Newell, Chief Engineer, U. S. Reclamation Service. On this particular project, Mr. J. B. Lippincott is Supervising Engineer, and Mr. Homer Hamlin is District Engineer.

GROUTED RUBBLE CORE WALLS FOR THE WEIRS OF THE DELTA BARRAGE, EGYPT.

A notable example of the successful use of grouted rubble masonry is furnished by the two weirs, known as the Damietta and Rosetta weirs, constructed to supplement the old Delta Barrage of the Nile in Egypt. These weirs are shown in cross-section by Figs. 1 and 2, and consist, as will be seen, of core walls, flanked on both sides by clay and rubble stone banks. The construction of the weirs and their purposes in connection with the main barrage were described in a paper by Major Sir Robert Hanbury Brown, M. Inst. C. E., before the Institution of Civil Engineers of Great Britain, March 15, 1904. From this paper we take the following account of the core wall construction, which was the portion of the work of greatest novelty and interest:

METHOD OF CONSTRUCTION.—The operation of constructing the weirs was conducted according to the following programme. A trench was first dredged out across the river bed to the dimensions and levels given in the diagram of weir cross-sections. The core and footing walls blocks were next formed under water, and brought up to a little above water-surface by the cement-grouting method to be described in detail later on. The clay was then piled into place against the walls through the water, and the rubble-pitching thrown in over it and in the space between the walls. The part of the core-wall above river-level was built as ordinary rubble masonry. At the same time, the heavy down-stream blocks of limestone, weighing 1½ tons to 2 tons each, were put in place. The surface slope of the weir was, last of all, built with special stones, about 0.5 m. long, placed on end and packed close.

While the weir itself was under construction, the lock at one end of it was being built, the foundations of the lock also being put in under water by the cement-grout

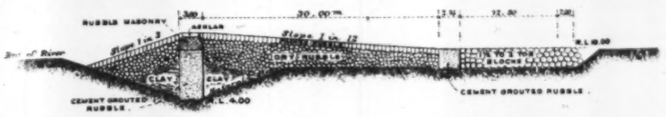


FIG. 1. CROSS-SECTION OF DAMIETTA WEIR AT DELTA BARRAGE OF THE NILE, EGYPT.

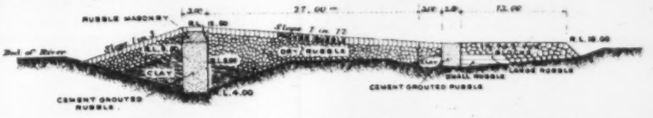


FIG. 2. CROSS-SECTION OF ROSETTA WEIR AT DELTA BARRAGE OF THE NILE, EGYPT.

piece, on each side, of 1 m. width, to make up the full length of the first box. Each group of sheet piles was weighted with old rails near the foot so as to make it float vertically for the purpose of easy handling and moving into position. It was also shod with a short shoe of sheet iron to secure a good junction with the river bed. Each piece was got successfully into correct position, bearing against upper and lower frames on the inside of them, and it was then lightly hammered with a monkey to drive it a short distance into the river-bed. The box being thus formed, the whole of the interior was lined with sacking, with overlaps at the vertical angles formed by the sides, and at the horizontal angles at the junction with the river bed. Finally match-boards, at 1-m. intervals, were nailed vertically over the sack lining to prevent its being torn or displaced while the rubble was being thrown in.

Before beginning to fill the box thus formed, four perforated pipes 5 ins. in diameter were fixed vertically along the axis of the box 2.5 m. apart. The next operation was attached to these balls was carried over a single-grooved wheel fixed on a stand over the pipe, and was kept taut by a small weight at the free end of the string. Below this weight was fixed a gage, so that the height to which the grout had risen in the bottom of the box could be read off the gage as the small weight moved down it.

The system followed was to pour grout into the two pipes prepared to receive it until the floats indicated a rise of about 0.5 m. at the foot of the other pipes. The filling pipes and floats then changed places, and grout was poured down the fresh pipes until the floats in the first pair of pipes indicated that the rise of grout was sufficient to require changing round again. As the grout rose in the bottom of the box, the inner tube was continually shortened by screwing off a length of pipe at the top, so that the column of cement might be delivered at a level just below the surface of the ascending sea of grout, the object being to avoid disturbing the grout previously poured in, that the process of setting might not be interfered with. Experience taught that it was wisest to commence the

system. The method of forming the two weir walls and the lock foundations under water is the point of special interest in this work.

CLAY FILLINGS.—A word, however, may be said about the method of putting the clay in place. The clay was a fairly stiff clay from the basin land within a few miles of the Barrage. It was not puddled at all, as it could not be puddled in place. The weight of the rubble overlying it was relied upon to compress it sufficiently to give it consistency. That the clay was thereby sufficiently compressed and compacted is shown by the fact that the surface slopes of rubble over the clay have scarcely settled at all after two floods, and the weirs are water-tight.

METHOD OF CONSTRUCTING CORE AND FOOTING WALLS.—In order to construct the core and footing walls along the dredged trenches made to receive them, it was necessary to devise and construct floating platforms from which to put together the boxes wherein the blocks were to be formed, as the core-wall had to be built in 7½ to 6 m. (24½ to 19½ ft.) of water, and the footing-wall in 2.5 m. in the case of the east weir, and 3 m. in the case of the west weir. The Public Works Department owned some large barges, about 30 m. (98 ft.) long and 6.5 m. (21 ft. 4 ins.) broad. These were put into repair and strengthened to form the rafts for use on the construction of the core-wall. A pair of them were rigidly connected by stout cross-timber, which also served to keep them apart, the one from the other, at a clear distance of 6 m. (19 ft. 8 ins.). Along the inner edge of each barge was laid a rail to take the travelling gantry spanning the space between the two barges. The gantry itself was of simple and even primitive construction, having been put together by the Barrage workshop with such material as happened to be to hand. This plant was classified by a Past-President and distinguished member of the Institution, when he saw it floating ready for its season's work, as "pre-historic." The gantry was long enough to allow of forming a block of 10 m. in length; the barges were long enough to allow of forming about 27 m. (88 ft. 6 ins.) length of wall, or three blocks, of 9 m. (29 ft. 6 ins.) each, in succession at one mooring.

The first operation was to float the raft into correct position and moor it rigidly on the true alinement of the wall to be formed. The gantry was then run to the end of the raft from which work was to commence. The first box, in which the starting-block was to be formed, was necessarily a four-sided box. The form of box (shown in Fig. 3 and now to be described) was by no means that of the first season, nor even that of the second season; but it was the form adopted for the construction of the Rosetta Branch weir as the outcome of the experience of the two previous seasons.

THE STARTING BOX.—This, being a four-sided box, was of fixed length, namely, 9.89 m. (32 ft. 5 ins.), internally. The interior width of all boxes on the core-wall was 3 m.

There were two rectangular timber frames to hold the sides and ends of the boxes together. The upper frame was slung from the gantry so as just to appear above water-level. The lower frame was weighted with old rails to make it sink, and was hung from the upper frame by chains of such a length that it was suspended at 4 m. depth vertically below the upper frame, and, therefore, 3.5 m. to 2 m. above the dredged bottom of the trench. These frames were slung into accurate position on the core-wall alinement and held there by four exterior piles lightly driven into the bed.

The sides of the box were then formed by 3-in. sheet piles with butt edges, fastened together in groups so as to form connected widths of 1.5 m. There was also a closing

simply to fill the box with rubble to water level. It was thought that the interstices would be decreased, and cement be therefore economized, by throwing in, simultaneously with the rubble 20% of concrete metal and 15% of desert pebbles. It is, however, doubtful if the addition of pebbles is desirable, as they find out a run and collect in masses, sometimes to such an extent as to stop the free flow of grout. Probably an even mixture of broken stone and rubble of all sizes, from concrete metal to the largest stone that a man can carry, would produce the most economical results.

GROUTING.—The box having been filled with stone to water-level, all was ready for grouting up the contents of the box to form a block of masonry 10 m. (32 ft. 9 ins.) long by 3 m. (9 ft. 10 ins.) broad, and 7.5 m. (24 ft. 7 ins.) to 6 m. high. The maximum height, 7.5 m., was that of the work executed at the commencement of the season; the minimum height, or 6 m. (19 ft. 8 ins.), was the height of the work carried out when the river-level had fallen to its lowest later in the season.

The extensive decks of the barges formed convenient spaces for stacking cement barrels, and for mixing the grout in iron troughs. Before experimental blocks were made to test this method of forming a subaqueous wall, with a view to its employment in such a work as these weirs, certain experts in the use of cement had expressed themselves as being little sanguine of success, expecting that the cement would be "drowned." It does not, however, appear to be such an easy matter to drown certain brands of cement when used as grout in continuous bulk. Those workmen who, during the course of the construction of the weirs, were set to demolish certain portions of the grouted masonry, must have fervently wished that the cement had been more effectually "drowned." The only fault that such demolition disclosed was that the masonry was too good for the work that it had to perform, if excess in good qualities can be reckoned a fault. It is only if it causes unnecessary expense that fault-finding has its opportunity; but in this case it is probable that the rapidity of progress, resulting from the adoption of the method of cement-grouting to form the walls of the weirs, secured such an economy on staff and general expenses, by saving one or two seasons' work, that no extra expenditure was involved in obtaining masonry of superior quality.

As soon as a smooth mixture of grout had been obtained in the troughs, the buckets were filled, and the cement grout was carried to the pipe-head to be poured down the pipe. But it was not poured directly into the perforated pipes; for, if this had been done, each bucketful of grout would have had to fall through whatever depth of water there was in the box, and some of it might also have escaped outwards through the pipe perforations. The condition of "continuous bulk" would not have been complied with, and there would have been good reason to expect that, under such conditions, "drowning" would have been the fate of the cement. But, in order that the cement grout might be delivered in a continuous column and not fall through water, an unperforated 3-in. pipe, made up of lengths screwed together, was introduced into the perforated pipe, and adjusted so that its lower end was a few centimetres above the dredged-out bed of the river. On the top of this pipe a funnel was screwed, and in the funnel was placed a wire-netting sieve to catch the paper of the cement barrels and other foreign matter which might have got mixed with the grout in the troughs, lest such substances might clog the perforations of the outer pipe and hinder the free flow outwards of the grout. Two of the four pipes of a box were thus prepared for the reception of the cement grout. In the other two were introduced wooden balls so weighted as to sink in water but float in cement grout. The string

formation of a block by pouring in grout to a depth of only 1.5 to 2 m., and then to leave it to set to form a solid bottom to the box; otherwise (as not infrequently happened at first) the head of liquid grout in a too-rapidly filled box forced a way under the sides and started a leak, by which much grout was lost and delay occasioned in setting matters right. As soon, then, as this bottom layer had set, the pouring of the cement grout was recommenced, and continued until the grout rose to the level of the water-surface inside the box, which was only slightly higher than that of the water outside; for though the boxes, as constructed, were grout-tight, they were not water-tight. Still, to facilitate the escape of the water displaced by the cement-grout, escape holes at outside water-level were made in the sides of the box.

AFTER GROUTING.—After the completion of the operation of pouring in the cement grout, the box and its contained block were left undisturbed for the remainder of the day and the succeeding night. The following morning, the block having set hard enough to stand without support, the outside guiding piles were lifted and suspended to the gantry; the end pieces of the box-frames and the sheet piles at one end of the box were removed, and the remaining sheet piles of the sides and other end of the box were lifted and suspended to the gantry. The whole gantry, with its suspended pieces—the outside guiding piles, the outside box-frames and side-pieces for a three-sided box—was then hauled along into correct position for forming another block in continuation of the first, leaving behind the finished block with the perforated pipes permanently embedded in it, and the sacking and match-boarding clinging to the block, as much of the sacking and match-boarding as would come away being subsequently removed.

These different operations were carried out with the assistance of a pair of divers to each raft. The divers' duties were the following: In putting the box together, they had first to see that the guiding-piles were in correct position with reference to the lower frame, and afterwards to make sure that the side-pieces of the box touched the lower frame on the inside, and were jammed up against the adjacent side-pieces, so that no open joints should be left. They had next to see that the curtain of sacking unrolled evenly, and to pay particular attention to the overlaps, weighting the bed overlap with stones. Lastly, they had to nail on the match-boards to keep the curtain in its place. In taking the box to pieces, all they had to do was to knock out the pins which connected one of the end beams of the lower frame with the side beams, and this only in the case of the first four-sided box. In the subsequent three-sided boxes their services were not required at all to help take the box to pieces, if everything had gone well.

THREE-SIDED BOXES.—The succeeding blocks, made in continuation of the starting-block, were formed in three-sided boxes, the last-made block closing the fourth side. The difficulty in the case of these three-sided boxes was to make the side beams of the lower frame grip the block firmly, as the least giving way to the internal pressure was followed by a leak of cement grout. It was easy enough to provide for the grip of the upper frame by cross-rods with end screws to tighten up, as the frame was partly above water-level. The difficulty as regards the lower frame was finally met by suspending rigid vertical beams of about 7.5 m. length to the gantry in such a position that the center of the beams touched the outside of the upper frame of the box. At this point the vertical beams were loosely held in place by an iron stirrup fixed to the upper box-frame, and this stirrup formed the fulcrum of the lever which the rigid beam was intended to become. The lower end of the beam

pressed against the lower box-frame, and the power to produce the pressure was provided for by a couplet of reversed screws fixed in the center of an overhead cross-beam connecting the two upper ends of the levers. This pair of levers was placed so as to act on the lower box-frames at above 2 m. distance from the free ends of the timbers forming the sides of the frames, so as to get a good grip on the last made masonry block which was to form the fourth side of the box.

The frames of the three-sided box had to be very rigidly tied back to the block already made; otherwise the weight of material in the box, when filled, caused a movement outwards of the whole box, and a resulting leak at the junction between box and block, a frequent occurrence at the commencement of the first season's work. When skill had been attained in putting the boxes together and in fixing them with absolute rigidity, it was seldom that anything went wrong, and the work progressed with great rapidity.

CUBIC CONTENTS OF BLOCKS AND RATE OF CONSTRUCTION.—A box and its contained block of 160 cu. m. to 170 cu. m. (208 to 221 cu. yds.) of grouted masonry took three to four days to make. The rate of progress was greatest during the third season's work, when the Rosetta Branch weir walls were constructed throughout their entire lengths. Six rafts had been got ready for the construction of the core-wall, but only five were used simultaneously. In addition to these, two rafts were specially designed and constructed by Mr. Edwin Mason for the building of the footing-wall. When the seven rafts were at work the core-wall advanced at the rate of 85 lin. m. (279 ft.) a week in 6 m. to 7.5 m. depth of water, giving 1,600 cu. m. (2,080 cu. yds.) of grouted masonry: at the same time, the footing and cross walls were constructed at the rate of 60 lin. m. (197 ft.) to 109 lin. m. (357 ft.) per week, or from 500 cu. m. to 750 cu. m. (650 to 975 cu. yds.) per week. It would have been difficult to have obtained so rapid a rate of progress had skipped concrete taken the place of grouted rubble masonry in the construction of the weir walls; and the well-sinking method could not have competed in pace at all. And not only was the pace good, but the result was superior to anything that could be obtained by the alternative methods.

DATES OF CONSTRUCTION OF WEST WEIR.—The west (Rosetta Branch) weir was begun on the 1st November, 1899, and by the end of that year three blocks had been formed. By the 7th April, 1900, all the grouted work below water was finished, including the core-wall of 500 m. (1,640 ft.) length, and its tie-back continuation into the east bank, the footing-wall (of 500 m. length) and five cross walls, each 30 m. (98 ft.) long, connecting the core and footing-walls, and also the foundations of the lock at the west extremity of the weir.

FOOTING-WALL.—The footing-wall was formed on the same principle as the core-wall, but in less depth of water, namely, 3 m. (9 ft. 10 ins.). The apparatus for constructing it was of less formidable dimensions and less pre-historic in style. The pontoons, by which it was floated, were parts of the complicated so-called self-acting gates which Mougel Bey had fitted into some of the Barrage openings before the work passed into other hands. The side-pieces by which the boxes were held together were fastened to vertical pieces attached to the pontoons and movable about pivots in cross-beams overhead. Long screws, working in cross-beams 2.25 m. (7 ft. 4 ins.) below the overhead beams, were made use of for moving the vertical beams with their attached cross-beams and floats inwards or outwards according as it was desired to form or to dismantle a box.

CLOSING CRACKS BETWEEN BLOCKS.—It may be worth while to describe a detail of the work which was doubtless a refinement in the case of these weirs; but, as it involved but an insignificant extra expenditure to obtain a continuous core-wall without a flaw from end to end, the luxury was indulged in. It sometimes happened that a crack appeared between the blocks of grouted rubble, probably due to slight settlement of the outer end of the last-formed block before the next block in advance had been made. In the Damietta Branch weir a bore was jumped in the center of the width of the core-wall along the line of the crack down to below the level of the clay filling, and after all the clay and rubble were in position on both sides of the core. Cement grout was poured down the bore to fill up the crack. When building the Rosetta Branch weir, in order to save the labor of jumping bores, it was contrived that vertical holes should be left on the junction line between two blocks, and these holes were afterwards grouted up as a last operation after the clay and rubble on both sides were in place, whether the cracks appeared or not. The vertical hole was formed by first fixing a semi-circular pole in the center of the outer end of the box being formed, and outside the box lining of sacking. After the block was completed, in the semi-circular grove thus formed, there was fitted a tapered rod, entirely covered by rope wound spirally and tightly round it. The next block, when made, enveloped the rod and rope. As soon as the block had set, the tapered rod was first extracted, leaving the rope behind; and the rope was afterwards pulled out with ease, leaving a clean hole from top to bottom at the junction of the two blocks.

Another system was also tried with fair success. The semi-cylindrical groove was formed as before described. When the next box was being formed, a plank was laid flat against the end of the last-formed block covering the semi-circular groove, which was then filled with sand at the same time that the box was filled with rubble. When this second block was being grouted, the sand filling kept out the cement; and when the time came for grouting the junction, the sand was easily removed, leaving the vertical hole to receive the grout.

PERCENTAGE OF CEMENT USED.—The quantity of cement used in the west weir to form 23,140 cu. m. (30,267 cu. yds.) of grouted masonry was 84,904 barrels (of 360 lbs.). This gives a rate of 3.67 barrels per cu. m. (2.8 barrels per cu. yd.), or 40% of cement. If there had been no leaky boxes, the rate would have been about 3.5 barrels to the cubic meter, or 37½% of cement, which may be taken to be the usual proportions for a successful box.

The very first two boxes made took, on account of leaks, 2,362 barrels of cement to form 327 cu. m. (425 cu. yds.) of masonry, or 7¼ barrels to the cubic meter (5.7 barrels per cu. yd.): that is, nearly 80% of cement. But experience was quick in teaching the right way to work, and the sixth box took only 3.6 barrels per cu. m. (2.75 barrels per cu. yd.).

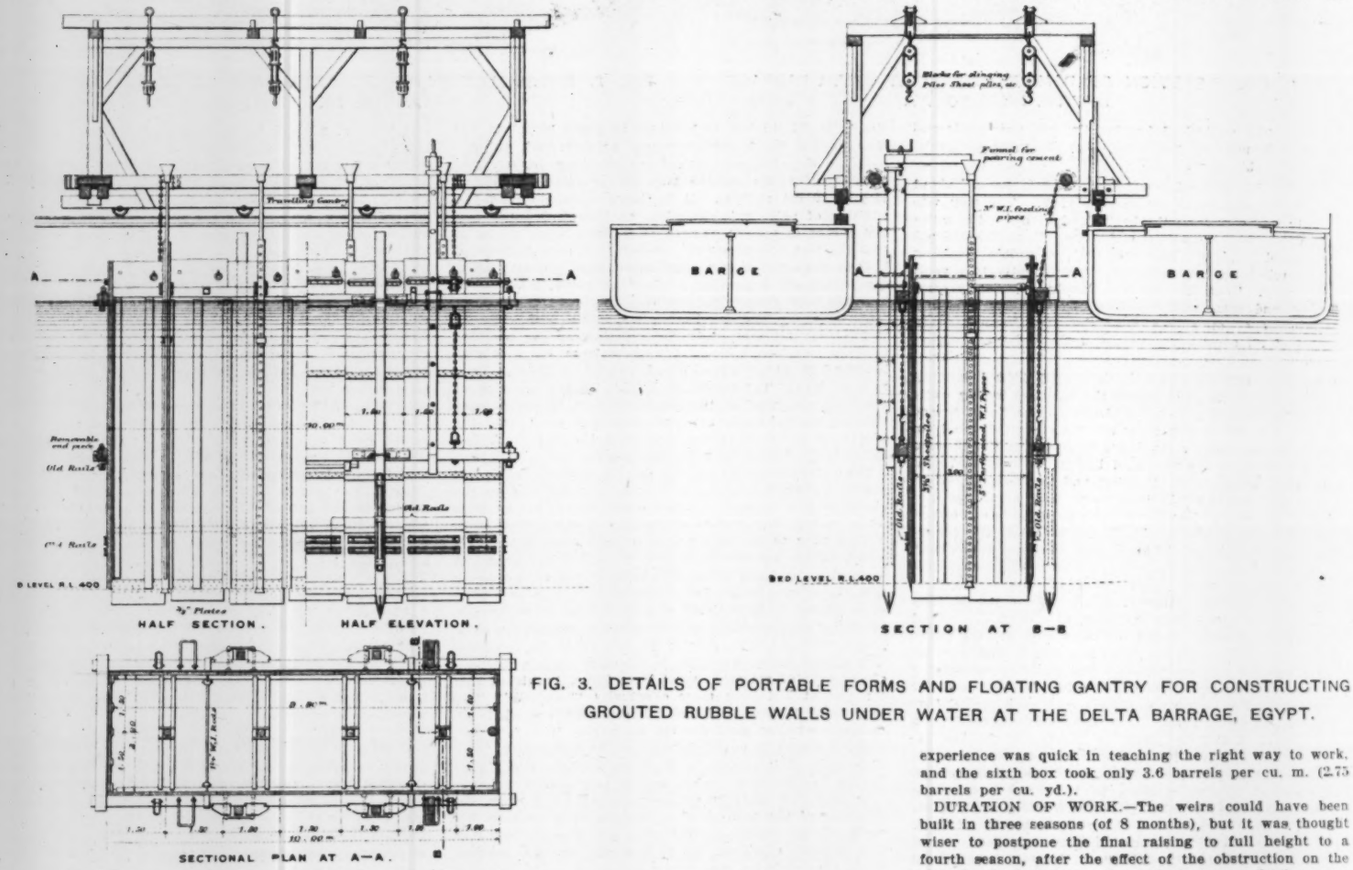


FIG. 3. DETAILS OF PORTABLE FORMS AND FLOATING GANTRY FOR CONSTRUCTING GROUTED RUBBLE WALLS UNDER WATER AT THE DELTA BARRAGE, EGYPT.

DURATION OF WORK.—The weirs could have been built in three seasons (of 8 months), but it was thought wiser to postpone the final raising to full height to a fourth season, after the effect of the obstruction on the river-levels had been observed during a flood season. Work began on the east weir by dredging on the 15th March, 1898, and block-forming on the 15th May. The first season's work was continued till the end of July, when 80 m. length of wall had been formed. The second season lasted from the 20th November, 1898, to the 31st July, 1899. During this season the east weir was continued and carried right across the Damietta Branch, and the lock-foundations and part of the lock-walls were built. The third season was a more successful one. The east weir and lock were completed and the west weir was carried right across the Rosetta Branch, and its lock also was completely built, with all its gates and gearing, in the single season of 8 months. There only remained for the 1901 season the building of 1 m. height of the core-wall of the west weir to complete the pair of weirs. This was leisurely done when it was most convenient, the last coping-stone being actually laid on 16th May, 1901.

STAFF.—The Author had the general superintendence of the work as Inspector-General of Irrigation in Lower Egypt. Mr. Allan F. Joseph, Assoc. M. Inst. C. E., as Director of the Barrage, acted as Resident Engineer for the greater part of the first season, and was succeeded, after an interval of a few months, by Mr. O. G. Brooke. Messrs. F. R. Stent, E. Mason, J. H. Grieve, Assoc. M. Inst. C. E., the late J. G. West and C. H. Boyes formed the staff that built the weirs and their locks.

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It is sound doctrine in engineering as well as in Holy Writ, that a structure exposed to floods, as was the house in the parable, should be founded on a rock to stand safely. Particularly is this true of dams. If a stream is to have its level raised by a wall built across it, that wall should go down to rock, or at least to a compact earth layer, impervious to water, or the difference of head of the water above and below the dam may force water through the permeable subsoil beneath the dam with sufficient force to carry off part of this subsoil and thus to gradually undermine the support of the dam itself.

But while it is sound doctrine to found your dam upon rock, what is the engineer to do when called upon to build a dam where no rock foundation exists and the structure must rest on nothing better than shifting sands? This is not a new problem in engineering. It was faced, in all probability, by the engineers of prehistoric days in constructing some of the great irrigation works, by whose aid it is probable some of the peoples of ancient Assyria and Chaldea gained prosperity. In recent times the builders of irrigation works on the plains of India have accomplished remarkable feats in the control of the rivers of India, and their success in building low dams on sand foundations has become widely known. Somewhat similar conditions have faced the builders of irrigation works in the Nile Delta.

In the present issue of Engineering News we illustrate four dams built on a permeable foundation. Three of them are structures of enormous size, two of them being built on the River Nile and the third about to be built across the Colorado River in Arizona by the U. S. Reclamation Service. It is of great interest to note how much the Egyptian and Arizona structures resemble each other. It is entirely probable that the engineers responsible for the design of the latter dam have closely studied the methods followed and the results attained by the Egyptian engineers.

The fourth structure is of insignificant size, but will for that very reason be of practical interest, we presume, to a large number of our readers. It is notable for being founded on piles, a cut-off wall of sheet piling being used to prevent percolation through the strata into which the piles are driven.

A fifth dam shown in this issue represents a notable application of concrete-steel to the construction of dams of moderate height. A feature which will appeal very strongly to engineers is the astonishing rapidity with which this dam was constructed. To build a permanent concrete dam nearly 200 ft. in length and 10 ft. in height in 22 working days is a feat hitherto unrecorded, to say the least. We need hardly point out that such rapidity of construction, enabling a dam to be built entire during a low-water period and reducing the risk of flood damage during construction, must form a strong recommendation of this type of construction.

The proposal to use copper or copper compounds as a germicide in potable water should be received with the utmost caution until more scientific data as to its efficiency and its non-poisonous quality are made public. The use of copper sulphate as an algacide is a very different proposition, inasmuch as algæ are not in themselves a menace to public health, so life is not endangered if the algæ are not killed, and the quantity of copper sulphate required appears to be much smaller than where used as a germicide. With a water believed to contain typhoid germs it is of the utmost importance that the method of treatment be known to possess a high degree of efficiency under the varying conditions of practical use on a large or small scale, and also that the method be simple in its application or else that its use be kept in the hands of experienced and judicious men.

After the foregoing words of caution we take pleasure in calling attention to an article on another page of this issue, based on recent statements by Dr. Geo. T. Moore and Prof. Henry Kraemer. It will be noticed that Dr. Moore is guarded in his expressions as to the circumstances under which copper sulphate may properly be employed as a germicide, restricting it to emergencies. His data of practical experience are meager, which may possibly be due to lack of space, and are particularly unsatisfactory in the case of the polluted spring which is said to have caused 50 cases of typhoid in less than a week, and the water of which is reported as having been "completely sterilized" by the use of copper so "it was possible to continue using the spring within five hours." One would like to know how it was demonstrated within five hours that the water had been rendered sterile.

Both Dr. Moore and Prof. Kraemer seem confident that the quantities of copper necessary to kill typhoid germs would be perfectly harmless to man, and we think there is much reason in their arguments in support of that position. But it is well to be cautious in so important a matter, particularly until the efficiency of the germicide under various working conditions has been more conclusively established and has also been more widely accepted by sanitarians than is yet the case.

To our minds the most serious aspects of this subject are the danger that undue reliance will be placed upon this germicide because of its cheapness, and that opponents of filtration will urge the use of copper sulphate by the water-works authorities or even copper foil and copper vessels by householders instead of filtration. This applies to public authorities and to advocates of low rates of taxation rather than to householders. If there were much likelihood that many householders would ever rely on copper vessels or copper foil as a protection against sewage-polluted water the consequences might be viewed with apprehension, both because of the uncertainty that all the water used for drinking and culinary purposes would be given any or sufficient contact with the copper and, on the other hand, the possibility that so long contacts would be allowed as to take up objectionable quantities of copper. The probabilities are, however, that in any given city householders as a class will never adopt effective means of copper treatment, and this is particularly true of the poorer classes of the population, who through lack of means or indifference are slow to take any such precautionary measure. Reliance must therefore be placed upon the treatment, by some method, of the whole of the public water supply, as has so often been shown to be the case where household filters and dual water supplies, one of pure and one of ordinary water, have been under discussion.

The stresses in wire ropes due to bending around sheaves were the subject of a paper by Mr. Samuel Diescher, recently read before the Engineer's Society of Western Pennsylvania. Mr. Diescher challenged the correctness of the formula and tables for bending stresses in wire ropes published in Kent's "Pocket-Book for Mechanical Engineers." The criticism is summarized near the opening of the paper:

> In the formula given by Mr. Kent, no cognizance is taken of the load hanging on such a rope, whereas, in fact, it takes more effort to bend a rope if taut than if slack.
>
> It seems that this formula was made under the impression that in bending a rope the conditions are about the same as if bending a solid bar; for, according to those tables, the stress produced in the wires of a rope 2 ins. in diameter, bent around a sheave 8 ft. in diameter, is 57,000 lbs. If this were correct, the breaking of ropes on inclined planes, elevators, etc., would be of daily occurrence, and necessarily the use of wire ropes for such purposes would have to be abandoned. The fact is, that the conditions prevailing in a wire rope while it is being bent differ very much from those in a bar subjected to the same operation.

Mr. Diescher then proceeds with a theoretical discussion of the stresses in a bent rope and reaches the conclusion that owing to the spiral lay of the wires and strands, tension on the outer side of the rope and compression on the inner side of the rope tends to neutralize each other. If the wires and strands were perfectly free to move upon each other, nearly perfect neutralization, he thinks, would occur; but the internal friction of the rope causes a resistance to bending and certain stresses in the rope.

Inasmuch as the wire rope tables in Kent's "Pocket-Book" have long been generally accepted by engineers as reliable, we deemed it worth while to investigate Mr. Diescher's criticism. We find that Mr. Kent took these formulas and tables from an exhaustive article by Mr. Wm. Hewitt, M. Am. Soc. M. E., for many years engineer of the Trenton Iron Co., well known as a prominent manufacturer of wire ropes. Mr. Hewitt's paper was originally published in Engineering News of May 7, 1896.

A copy of Mr. Diescher's paper was sent to Mr. Hewitt, with a request for comment thereon, and we append his reply as follows:

> The formulas given in Kent's "Pocket-Book" for determining the bending stress in wire rope corresponds very closely with the formulæ given by other authorities, and differs from the others in the fact that it makes allowance for the double spiral lay of the wires, and the conditions of bending are *not* considered the same as that of a solid bar. This formula simply gives the bending stress, to which the load stress is added in determining the total stress.
>
> Taking the case of a 2-in. rope on an 8-ft. sheave, the bending stress of which is given in the table calculated from the formula referred to as 57,000 lbs., I cannot see why Mr. Diescher should draw the conclusion that he does, because the maximum stress that such a rope made of steel wires would safely sustain is very much greater than 57,000 lbs. The conclusion arrived at in Mr. Diescher's investigation, that there is a compensating action in the wires whereby the bending of a wire rope takes place without severe stress in any part of the strand, owing to the tendency to pull in the upper part being equal to that to shove in the lower part, is not borne out by practical results.
>
> After many years' experience with wire ropes, I am convinced that the formula given in Mr. Kent's book is correct and reliable.

About a year and a half ago* we had the pleasure of presenting a description of the iron framing of an old New York City building, containing forms of built-up beams that were devised and successfully used at about the time when the rolled I-beam was born. Most interesting of these forms was a beam of I-shaped cross-section made of two thin web-plates each bent to channel form, riveted back to back, and cover-plates riveted on the outstanding flange portions of the web-plates. We now learn that identically the same beam construction has been "invented" and patented in Germany. The fact is interesting, less perhaps because it illustrates that a patent is not always the proof of novelty, but rather because in this day of the steel I-beam's supremacy we find that the inventive spirit turns back to a construction which was

*In Engineering News of Sept. 10, 1903, pp. 214 and 223.

used, by force of necessity, before rolled I-beams were available. There is, in this German patent, an unconscious tribute to the skill of the unknown designer who fifty years ago devised the bent-plate I-beam as a contribution to fireproof building construction of that day.

In the recent annual report of President Henry S. Pritchett, of the Massachusetts Institute of Technology, one of the most interesting parts relates to the compensation of instructors and professors of engineering. We quote as follows:

> The fact is, under the system of specialization which has grown up in the last 20 years, a man who aspires to a professorship may count upon the following programme: First of all he must spend four years, at considerable cost, at college or university or technical school, with some three years to follow as a specialist, including, as a rule, a year or more at some foreign institution, engaged in work which is quite as hard as that which prepares men for the law or for medicine or for any other profession. After this six or eight years of preparation he may hope to become an assistant, or at most an instructor in some institution of learning at a salary of $700 or $800 a year, and he will be a man of unusual attainments if at the end of ten years he has been advanced to an assistant professorship at $1,500 a year, a salary not much better than the wages of a switchman in one of our large railroad yards. Furthermore, the chances are that during this time he will be so burdened with classroom work, with administrative duties, and with other tasks outside those properly belonging to a teacher's life that there will be little time or strength left for quiet study and research. The strenuous life has been introduced into the colleges and universities with consequences as much to be regretted as those which have come in business.
>
> This result is due in part to the multiplication of so-called universities, to the great increase in numbers without corresponding adjustment of the organization, and to the wasteful competition in education which has come about by the great number of institutions all trying to do the same thing. Whatever may be the causes, the condition is evident enough, and some solution must be found which shall give the teacher greater freedom from the administrative side of the work and which may at the same time increase his compensation.

The compensation of professors in engineering schools, and particularly of their assistants, is unquestionably far below what men of their responsibility and training ought to receive. Were it not that the teaching instinct is stronger in some men than the commercial instinct, our professors would be a sorry lot indeed. It has been urged that, so long as good men can be found willing to sacrifice themselves to carry on the work of the schools to which they are attached, it would be poor business policy to increase their salaries, particularly in view of the meager funds usually available. This is an old argument that has been applied to our common schools, with the result that the vast majority of common school teachers are women, for men cannot afford to work for the low salaries that are paid. In our engineering colleges, for a similar reason, the young instructor who is able and ambitious is apt to be attracted by the better opportunities outside of the college; and, unless his love of teaching is unusually strong, he serves but a short apprenticeship as a teacher. Several factors operate, however, to keep some of the most able men on the teaching corps of engineers. One of these we have already mentioned, namely, the instinct for teaching. Another is the attractive social features of residence in many university towns, in contrast with the nomadic life of most engineers engaged in professional work. Still another factor, perhaps stronger than is commonly supposed, is the natural reluctance to make a change. Having once started upon any career, there is a tendency to cling to it. If disagreeable features are encountered, it is argued that they are in all probability evils that will be overcome in time, and, in any case, are probably no worse than would be encountered in other walks of life. The eyes of all are fixed upon the few who reach high places rather than upon the many who never rise above mediocrity.

In recent years, several institutions have adopted the plan of pensioning superannuated professors; but whatever the merits of this plan to benefit certain specially deserving men, it does not, we believe, commend itself for general adoption. Most professors, we are sure, would far rather receive salaries sufficient to enable them to save enough to provide for their old age rather than be compelled in their declining years to accept money while performing no service.

Our engineering schools, as a whole, have been favored with enormous benefactions during the past few years; but, in too many cases, these benefactions have been given to erect palatial buildings, which have constituted an actual drain on the institution's income. Have we not perhaps gone too far in the craze for expensive buildings and equipment in our engineering schools, and overlooked the great fact that the strength of a great university, or college, or school, lies nowhere else than in the men who conduct it, and who put their individual personality into the work of instruction and education?

DAMAGE TO FIREPROOF BUILDINGS IN THE BALTIMORE FIRE.

Exact figures of the destruction wrought to fireproof buildings by the Baltimore conflagration of a year ago are given in another column of this issue. At the time of the fire, prominent engineers and architects estimated that the fire loss on fireproof structures would run from 25 to 40 per cent. of the sound value of those buildings. The final figures of the appraisers' estimates show that the actual damage was from 60 to 75 per cent. of the sound value of the buildings. The discrepancy can be partly accounted for by the fact that no allowance was made in the original estimates for the cost of removing sound material in order to remove and replace damaged material; but making all allowances possible, it is evident that the original estimates of the destruction to fireproof buildings at Baltimore were woefully inadequate. Not only is the actual money loss double the amount first estimated, but the loss due to the time required to get the buildings into shape for occupancy is multiplied several times.

Taking the evidence as it stands, a fair summary of the fire record of the fireproof buildings that passed through the Baltimore fire is about as follows: The tenant lost all that he had, his loss could not have been greater had he occupied a timber shanty. The building owner lost from 60 to 75 per cent. of the sound value of his building. He also lost the income from his property for a period approximating the time required to build an entirely new building. Altogether then, the total gain from these buildings having been of fireproof construction is a saving of from 25 to 40 per cent. of their sound value in materials and workmanship. It is natural enough in view of this showing to find the old question of the commercial value of fireproof construction again being raised.

To answer this question we have first to consider whether the records of damage in detail give us hope that readily practicable modifications in fireproofing materials and workmanship are possible and whether such modifications will give us more fire-resisting structures. According to the report which we publish elsewhere, there was a loss of 56.4 per cent. on the 23 buildings classed as fireproof by the committee. Of these 23 buildings only six come within the definition of tall steel cage fireproof buildings. The losses on these six buildings will be found by summarizing the detailed figures to be as follows:

Union Trust	61.5 per cent.
Calvert	57.3 " "
Herald	58.7 " "
Continental Trust	64.8 " "
Equitable	74.3 " "
Maryland Trust	60.0 " "

The itemized table of damages which is published in the report shows clearly the distribution of these percentages of total loss among the several structural items of the various buildings. As might be anticipated, there is a very heavy loss on trim and finish and on equipment. These are parts of a building which, from their character and the nature of the materials used in their construction, we naturally expect to lose in any fire of a general character. On the other hand, it is the cardinal theory of fireproof construction that while the finish, equipment, and furnishings of a fireproof building may be destroyed, the structural integrity of the building will remain practically undamaged. Turning to see how this theory was borne out at Baltimore we discover a loss of some 53 per cent. on mason work, of about 12 per cent. on the steel frame, and 2½ per cent. on the foundations.

Reviewing the damage to foundations, it will be seen from the table that the injury was chiefly to superficial parts. The integrity of the foundations was not disturbed, they were as capable of performing their duty of supporting the superstructure after the fire as they were before. With the steel-work the case was different. Here the fire did material injury to the strength and soundness of the structure. If we scan the figures carefully, however, we shall note that the high percentage of loss which is recorded comes from the excessive damage done to the framework of two buildings. To quote: the Herald building suffered 31 per cent. loss on its steel frame and the Equitable Building suffered 42½ per cent. loss. The reason for these excessive losses is found upon perusal of the individual reports on the two buildings named. In the Equitable Building the fireproofing of the steel was a farce, it was scarcely more efficient than a wooden joist and plank flooring. Faulty design and light construction was likewise responsible for the steel damages in the Herald Building. In a word, neither the Equitable Building nor the Herald Building was a fair example of modern steel cage fireproof construction.

The steel losses in the other four tall buildings ran from 1.03 per cent. to 9.4 per cent.; it averaged for the four structures 4½ per cent. Furthermore, if we examine the individual reports on these buildings we find that in case of the two which suffered the greatest damage to their steel frames we must charge the greater part of the damage to the obviously faulty construction of certain parts. Eliminating the two buildings which were neither of modern construction nor of good old type construction and also eliminating the special parts of the Continental Trust and Maryland buildings which failed because of poor design and construction, we find that the loss to the steel frames comes well within 2 per cent. of their sound value. In making this analysis the intent is not to belittle the figures that we quote, but to make plain that there is no serious fault in the principle of modern steel cage fireproof construction and that the fault lies in violating the fundamentals of good design and good workmanship on which the successful operation of this principle depends.

Turning now to the items comprised under mason work, we find a record of loss which runs from 31 per cent. on common brick to 89 per cent. on fireproof partitions. It is but fair to say that the greater part of the recorded loss on brickwork is due to the necessity of removing it to allow other more damaged materials to be replaced with new material. Stonework failed in every case in which the fire got a fair chance at it; it is doubtful if it can be hereafter admitted to a place among the list of materials suitable for fireproof construction. Next to brick the appraisers' report ranks terra cotta as the material which best resisted the attack of flames. It is a little difficult to see the justice of this conclusion.

The figures show a loss of 82 per cent. on this material. In view of this fact there can be no reason for ranking terra cotta so high unless it can be shown that much of the damage done to it was caused by something else than weakness in the material itself. Moreover, we are not, as building owners, concerned so much with the ability of terra cotta, per se, to resist heat as we are with the ability of terra cotta construction to retain its integrity under such attack. Terra cotta construction did not stand well under fire at Baltimore. The reason for this is plain upon search. Terra cotta column covering failed largely because it was torn off by the expansion of pipes run between it and the columns; terra cotta floors failed largely because their lower flanges cracked off and because the beam flanges became uncovered and warping resulted, which broke down the arch blocks; terra cotta partitions failed largely because they were laid with wooden strips at the floor and ceiling and because they were cut by wooden window and door frames, and terra cotta furring failed largely because after being placed it was cut into right and left to make places for

pipes and wires of various sorts. This is all faulty construction, doubtless, but it is terra cotta construction as it is usually carried out in building work and it is not successful fireproofing.

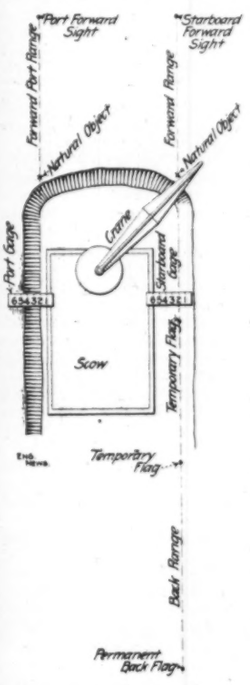
What is the lesson taught by the facts as we have found them? It is that the failure of steel frame fireproof buildings in the Baltimore fire was due largely to faults in design and construction which can be remedied with care and attention. It will cost more to build in this way than it does to build carelessly, but it must be done if modern steel cage fireproof buildings are to be fire-resisting in anything else than name.

LETTERS TO THE EDITOR.

A Method of Alining a Dredge.

Sir: The accompanying sketch represents a plan devised by me for alining dredgers in canal cutting.

To both the starboard and to the port gunwales of the scow a gage is securely spiked. A 3 × 12-in. gangplank serves the purpose well. These plank gages lie at right angles to the axis of the scow, and are directly opposite the "runner's levers." Upon these gages are scribed a series of numbers such that the distance from any number upon the starboard gage to the corresponding number upon the port gage equals the required width of the canal at the water line.



A permanent back-sight flag is set on the starboard water edge of the canal, and at the end of the proposed tangent two permanent fore-sight flags are set, one upon the right, the other upon the left proposed water edge.

At the beginning of a day's dredging the "runner" sets a temporary flag just aft of the starboard gage, in range with the starboard back sight and the starboard fore sight.

After each move of the dredge he walks out on the starboard gage until upon the back-sight range formed by his temporary flag and the back-sight flag. Then turning right about face he notices some natural object upon the forward cutting in range with the forward starboard sight.

Noticing the number that he stands upon, he then crosses over the scow and walks out upon the port gage until he stands upon the number corresponding to the number in his starboard range. Then selecting some natural object upon the forward cutting, in range with the forward port sight, he returns to his levers and cuts to these natural objects.

The process of picking up the points is accomplished almost instantly, and only requires the time necessary to walk out upon and return from the gages.

Ordinarily the forward flags may be replaced by selecting some distant natural object in the range line produced.

When the distance to the forward object is great, the point is considered to be in both ranges.

The method insures a workmanlike finish to the side slopes.

In the reclamation of the Blitzen swamps of Oregon, I applied this method of alinement to a dipper dredge with great success. It would have been nearly impossible to have set range poles ahead of the dredging, because of the almost impenetrable jungles of tule, cane brake, and willow, combined with deep water and marsh mud.

Yours truly, Ralph E. Parker.

Room 10, 320 Sansome St., San Francisco, Cal., Jan. 18, 1905.

Is Day Labor Cheaper than Contract Work?

Sir: Your editorial in the issue of Jan. 26, with the above-mentioned caption, can hardly be answered in a hard and fast manner for the reason that circumstances which alter cases reappear just about as periodically as the statements regarding the two methods of carrying on work. It seems to the writer that with uncertainties removed so far as possible, and a provision for equity to cover matters and details impossible to provide for in advance, the competitive contract method would result in the greatest actual economy and a better class of work accomplished. The engineer should have sufficient courage and sincerity to stand squarely upon the facts regardless, to a great extent, of which side employs him. The buyer certainly desires to know the facts, and where they will be likely to lead him no matter how or by what process the work may be done, or how the contractor, if there be one, fares in the matter. And of course the contractor absolutely needs to know the facts, not only as to what may be closely figured upon, but also as to the uncertainties of the case and how they will be likely to affect him and his interests.

In any kind of work which involves going beneath the earth or the water, it sometimes costs a good deal of money to ascertain, in advance of the letting of the contract, all or most of the difficulties likely to be encountered in carrying out the enterprise. If this preliminary expense is avoided and an attempt made unfairly to throw responsibility upon a contractor, a far greater expense is not unlikely to be encountered by the owner, as the contractor clearly has the advantage in legal position. No specious wording of specifications can save the engineer from taking a reasonable amount of the actual responsibility, and if he will clearly set forth, sharply and distinctly, the positive position of the contractor, providing as completely, as it is practicable to do, for unknown quantities, thus giving the contractor a definite point to figure from, good competition upon a proper and equitable basis will surely be obtained. And under such conditions the ultimate cost of the work will in most cases be less under contract than under day labor.

There may be, of course, cases wherein preliminary or subwork, on account of unknown conditions existing beneath the surface, could practically be done at less cost by day labor than by contract; and not because the contractor could not handle matters as economically as could be done by day labor, but for the simple reason that a day labor scheme really provides for all facts that may be met with, and, when they are met with, throws no unusual responsibility or chance upon any one. Whereas, when the contractor is asked to bid upon uncertainties he very naturally and very justly figures so as to make the owner pay for such chances if the extra expense may possibly be met with. Then, if trouble and expense fail to materialize, the work costs more than the eventually ascertained facts justify, but as the contractor has been made to assume the chances, he is fairly entitled to the extra profits; he gets them, at any rate, and the work then comes to a higher figure than necessary.

Engineers in preparing specifications often arrange matters so as to retain full control and authority within their own hands, but attempt to throw all of the responsibility upon the contractor for furnishing all unknown and unknowable labor and materials that may possibly be required. The simple principle of law that if you take a man's goods you must pay him for them, protects the contractor completely, but it may cost a law suit to reach conclusions; and, rather than go to such an extreme, it is much easier to provide for uncertainties by higher bids. Hence, contractors' estimates under specifications and conditions may be higher than day labor accounts upon apparently similar work. Yours respectfully,

Chas. A. Hague.

114 Liberty St., New York, Jan. 28, 1905.

Belt Conveyors in the Plant of the Lake Shore Stone Co.

Sir: In your issue of Jan. 19 there appears an article descriptive of the plant of the Lake Shore Stone Co., at Stone Haven, Wis., and of the steamer "Hennepin," owned by that company, in which article it is made to appear that the substitution of the cable road system in place of the belt conveyors for conveying stone from the crushers and stock piles to the bin situated at the end of the pier, was made on account of the heavy cost for operation and maintenance of the belt conveyors. The inference which might be drawn from the article is, that as a general proposition belt conveyors for the conveyance of crushed stone are not a success, and especially that it was an error of engineering judgment to select them for the long haul on the pier.

To this I must take decided exception, and as I designed, constructed and operated the Lake Shore plant, I believe that I am qualified to speak intelligently upon the matter.

The total length of the conveyor in question was in the neighborhood of 1,300 ft., divided into two equal sections, each of them driven by a motor at the head pulley. It is my opinion, formed after careful investigation, that the trouble with these long conveyors was caused by the poor design of the particular make of belt conveyor which was installed, rather than by bad judgment on my part in deciding that the work should be done by belt conveyors. There are in successful operation many belt conveyors of greater length and performing heavier duty than those on our pier, and I am satisfied that if our conveyors had been similarly designed they would never have been discarded in favor of a cable road.

The facts in the case of the Lake Shore plant are as follows: When we were ready to purchase our conveyor equipment I invited a well-known manufacturer to send an engineer to our plant, having first selected a concern which has had the largest experience in this branch of engineering and had demonstrated its ability in handling heavy materials. In company with the firm's engineer I designed the general arrangement of conveyors, and shortly after received, with his proposal, drawings of the entire conveyor system, including the equipment of the steamer "Hennepin." Now, all these drawings were in detail with the exception of those showing the long conveyors on the dock, and it is interesting to note that these dock conveyors were the only ones which afterwards gave us serious trouble.

The proposals having been received, both from the company which had designed the plant and from others, I was instructed to place the order with the lowest bidder and to turn over to that concern all the detailed drawings which had been prepared and delivered by the other concern.

When the conveyors on the pier were being erected I objected strongly to the small size of the head pulleys, which were only 24 ins. in diameter. My objections were, however, overruled with the statement that the contractor had guaranteed a capacity of not less than 250 cu. yds. per hour, and that this should be considered sufficient. But when power was applied the belts refused to start, and although the contractor made several attempts to improve the installation, the conveyors would never carry more than 100 tons per hour. When that quantity was exceeded the belt would slip and stop, making it necessary to shovel the stone from the conveyor and thus lighten the load. To any one familiar with the conditions at a plant equipped with a No. 9 crusher, it is unnecessary to detail here the trials of a manager desirous of obtaining economical and profitable results, upon finding it necessary to shut down everything several times a day for such a cause as that just described.

I would also state that although we supposed that we had bought the cheaper conveyor the ultimate cost of the conveyors erected was far greater than it would have been had we adopted a standard belt conveyor, with self-contained idlers ready for immediate attachment to our woodwork. The millwright work in setting four bearings for each idler, which was necessary in our case, amounted, ultimately, to a sum exceeding the difference between the price which we paid for the machinery and that for which we could have bought a better type of conveyor. In fact, the more expensive conveyor would have cost us $10,000 less than did the "cheap" one by the time the latter was erected. This does not include any losses due to delay, or the cost of belts worn out, and this latter item is an important one, as I believe that our belts were worn out more quickly by the idlers than by the stone which they carried.

I believe that, in its field, it is difficult to find a more efficient conveying device than the cable road, but I maintain that my selection of the belt conveyor in the instance especially referred to would have been justified by the results if I had not been overruled in my selection of the concern with whom I wished to place the contract. In a stone crushing plant all the machinery is subjected to the most severe usage, and there are so many necessary difficulties to be overcome, that success is impossible unless the strongest and most durable equipment is provided. For our work the best is none too good.

Yours truly, Frank N. Merrill.

Shelburne Falls, Mass., Feb. 3, 1905.

Ritter's Formula for Reinforced Concrete Beams.

Sir: Replying to the criticism on my investigations of Prof. Ritter's formulas, published in your issue of Jan. 12, 1905, under the sobriquet of "Engineer," I beg to take exception to some of this writer's statements.

In my letter of Jan. 5th, I "labelled" the values c and f, intensities of stress of concrete and steel respectively, because that is precisely what they represent in the mathematical solution that I presented. They are not intended to represent "intensities of stress at unit's distance from the neutral axis," as your correspondent claims, nor could an intelligent reading of the deduced formulas containing these quantities give rise to any such impression. To make my deductions a little clearer to those not familiar with concrete formulas, I should perhaps have defined c as the maximum intensity of compressive stress, being the stress, of course, in the upper surface of the beam, or the stress at the distance u from the neutral axis.

To adopt an entirely new nomenclature, such as the one furnished by "Engineer," would make correct his equations:

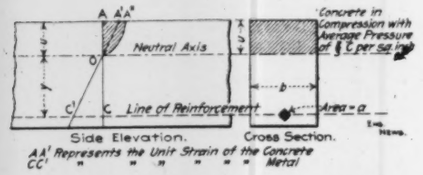
$$cu - \frac{2}{3} bu = fya$$

and

$$\frac{c}{E_c} = \frac{f}{E_f}$$

If your correspondent had gone a little deeper into the question, he would have found that his two equations would have led him to exactly the same conclusion as that reached in my letter of Jan. 5, and thus invalidated his criticism.

The charge that has been brought against Prof. Ritter's formulas is such a serious one that I would be glad to see it discussed in a serious and comprehensive manner, and have therefore added the following to make my point a little clearer.



Let c = maximum intensity of compressive stress in the concrete. It is represented by the distance AA'' in the sketch.

Let f = maximum intensity of tensile stress in the metal. The area of reinforcement is assumed to be so small with reference to the total area of cross section of the beam that the stress in the metal is practically uniform.

Let A A' represent the unit strain in the concrete under stress c.

Let c' c represent the unit strain in the metal under stress f.

Now the total compressive resistance is represented by the area of the parabolic figure A O A'', multiplied by b, the breadth of the beam.

$$\text{But A.O.A''} = \frac{2}{3}\,(AA'')\,u = \frac{2}{3}\,cu,$$

and breadth of beam = b.

$$\text{Therefore the total compressive resistance} = \frac{2}{3}\,\text{cub.}$$

Now the total tensile resistance is evidently the area of cross section of the metal multiplied by the uniform tensity of stress. Therefore the total tensile resistance = af.

Since all authorities agree that the total compressive resistance above the neutral axis is equal to the total tensile resistance below the same, we have:

$$\frac{2}{3}\,\text{cub.} = af;$$

$$\text{and since} \quad \frac{c}{E_c} : \frac{f}{E_f} = AA' : CC',$$

$$\text{we obtain the equation,} \quad \frac{2}{3}\,ub = a\left(\frac{y}{u}\,\frac{E_f}{E_c}\right)$$

This is precisely the equation which results from the two equations presented by "Engineer." Now $\frac{2}{3}\,ub$ is an area which may be multiplied by c (the maximum allowable stress in concrete), to give the total resistance to compression, or $\left(\frac{2}{3}\,ub\right)c$.

Therefore, a $\left(\frac{y}{u}\,\frac{E_f}{E_c}\right)$ must be an equivalent area, and to obtain this equivalent area we multipy a, the area of steel, by the factor $\left(\frac{y}{u}\,\frac{E_f}{E_c}\right)$. This factor is always greater than the factor allowed by Prof. Ritter. The latter multiplies the area of steel by the factor $\left(\frac{E_f}{E_c}\right)$, and it will be readily seen that the factor $\left(\frac{y}{u}\,\frac{E_f}{E_c}\right)$ must be greater than this, and may be even double, as the ratio $\frac{y}{u}$ increases as the percentage of reinforcement is decreased.

The fact that these formulas of Prof. Ritter's, having such a striking error in their deduction, are used by a large number of so-called "concrete engineers" only serves to show how uncertain is the knowledge of even the simplest mathematical rules governing this form of construction.

Respectfully yours,
John Hawkesworth.

100 West 80th St., New York City,
Jan. 13, 1905.

The Value of Mechanical Bond in Reinforcing Rods for Concrete.

Sir: The writer has been gradually accumulating a library on the subject of reinforced concrete, and has also been looking into this form of structural work with considerable interest. He has lately looked over some plans of arches for friends of his, and found them to be so well proportioned as regards the ratio of span to rise that no reinforcement of steel is necessary. After some work, he was able to recast the lines of the structures and save considerable concrete. His friends confessed that arch design was something new to them, and as they found a great many conflicting theories and formulas, they chose that which gave the greatest apparent factor of safety, and added the reinforcement to make sure. Unless some considerable information is scattered broadcast many engineers will so design structures, and theirs will not be erected, but instead there will be many a dangerous structure put up, and reinforced concrete will suffer.

Take, for example, an advertisement of a well-known deformed rod. It states, "adhesion not necessary." Surely the man who is thus advertising must be joking. He cannot mean it. If he means just what he says, there will be many a faulty structure erected with his rods.

The writer does not for one minute believe in this hypothesis of a mechanical bond which becomes less as the years go by. If this hypothesis be true (the word is used advisedly as distinguishable from theory), then reinforced concrete is one of the most dangerous things an engineer can fool with. Take, for example, a bridge such as the Luten arch, with the steel rods on the tension edge. Mr. Luten uses plain rods. Is not the life of it dependent upon the perfect bond between the steel and concrete? When the bond is gone the bridge will be gone. The use of deformed rods is becoming an unreasoning fad, with little but hypothesis to justify it.

In all experiments thus far made the adhesion has been shown to exceed the shear. In the various forms of deformed rods on the market the projections are so close together that the little shoulders of concrete between are bound to be sheared off whenever the adhesion is destroyed to the extent that the principle of mechanical bond is called into effect.

When the perfect adhesion is destroyed, then air and moisture can get at the steel to corrode it. As corrosion proceeds, the concrete will be called to carry all the tensile stresses, and as the structure is not so designed there must be a failure. The writer sees from recent discussions that the matter is rapidly resolving itself into a question of high elastic limit. Have bridge engineers with wide experience found a high elastic limit or low elastic limit steel most suitable? Can we who are going to design works in concrete steel follow safely their lead? Which will develop in the most rational manner—the full compressive strength of the portion of the reinforced beam designed to carry the compressive load?

The writer does not think the adhesion is destroyed in time, so that projections on the rod are necessary. If they are, then as stated above, they are generally so close together that the full strength of the concrete in shear is not developed, and the material will crack along the

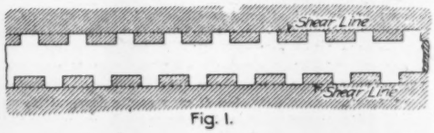


Fig. 1.

line indicated in the accompanying diagram, Fig. 1. In this diagram no particular rod is represented, the sketch simply being a general representation of all such rods.

The writer begs to offer the following sketch, Fig. 2, of a rod with projections, and offers it to the profession in-

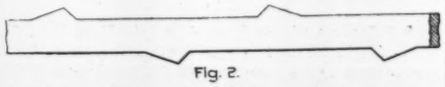


Fig. 2.

stead of trying to secure patents, for the reason that he thinks the day of deformed rods will soon be over. If they are right in theory, then reinforced concrete will soon have an appalling list of victims to account for, by reason of the structures which will fail when the adhesion is destroyed. It will then go out of use. If the theory (hypothesis) on which the use of deformed rods is founded is untrue, then there will soon be no sale for them, and plain rods will be used.

In the above rod the projections are proposed to be only on the bottom and top of the rod. They will be spaced ten times (or thereabouts) the thickness of the rod apart. They will be alternated, as shown. If it is considered advisable to put in shear ties it will be an easy matter to attach them.

What becomes of the rust? The writer about a year ago made four blocks of concrete of a 1—2—4 mixture, and imbedded in them ordinary iron rods which were badly rusted, simply washing them clean before putting them in place. These blocks were broken a couple of weeks ago, and the rods were comparatively clean and bright. The rust was gone, but was not adhering in scales or flakes to the concrete. It seemed to have entirely disappeared, leaving some discoloration of the enveloping concrete. The adhesion to the rods was seemingly perfect. This experiment was made in the most casual way, and for the reason that the material was at hand, and there was no other use for it. The rods were short pieces cut from ends of long rods put in some work. The concrete was a little left over from a job. In an idle way the writer wondered what the effect of rust might be on the adhesion, and so made the blocks. No tests of the amount of adhesion were made, but it might be stated that it was a matter of considerable difficulty chipping the concrete off the iron.

Some day some more complete experiments will be needed, and it is to be hoped our universities and technical schools will work on this line and determine whether it is safe to advertise "adhesion not necessary."

The writer believes adhesion to be the most necessary thing. Without it we had better abandon such hybrid material. We cannot be too careful. We must persistently advocate the most uniform concrete mixing which can be obtained (demanding machine instead of hand work), and see that when the metal is put in place the concrete thoroughly envelops it. As the concrete absorbs moisture, it will surely expand and thus more tightly grip the steel.

The writer feels that he is treading on most delicate ground when he sends in this communication. He, however, heard a conversation a short time ago between two contractors, and the gist of it was that they believed the projecting points of the stone caught between the corrugations and held the rods immovable. He told them to guess again, and they said they guessed the man who invented the rod knew his business, and a man could use anyhow that a rough rod would hold better than a smooth one. The writer is prepared to say that it is a matter of indifference to him whether he uses a smooth or a corrugated or any other form of deformed rod. He will in any case believe the adhesion will be sufficient to develop enough of the tensile strength of the metal to develop the full compressive strength of the compression side of the beam. What more do we want? Is the great apparent strength of the bar due to the projections or to its high elastic limit?

The matter of bars being settled, what about the concrete? A mechanical engineer said, "I have some concrete work to do. I have asked a dozen civil engineers about the proportions to use, and I get as many different proportions as there were engineers giving them to me. You fellows do not seem to design concrete on a rational basis yet." He called it designing concrete. The writer knows perfectly sound structures having one part of cement to twelve parts of aggregate, and still he knows engineers who are horror struck at the idea of anything leaner than one to six or eight.

We must stop mixing concrete by hand, and insist upon perfect machine-mixing. We must study different proportions of concrete, so that given mixtures can be determined for given situations with the greatest economy of cement. We must know to just what extent the voids are filled and to what extent it is necessary to fill them.

Lastly, but most important in fact, we must have definite experiments made on a large scale to determine whether or not a deformed rod is necessary. If it is, then good-bye to reinforced concrete. A bond is no good unless it is continuous along the entire length of the rod, and yet numerous corrugations are dangerous for the reasons above shown.

The sooner it is settled, however, the better, or a few accidents will cause the world to lose confidence in engineers who advocate reinforced concrete, and the profession as a body will suffer.

Yours truly,
Ernest McCullough.

Chicago, Ill., Jan. 15, 1905.

Notes and Queries.

In the description of the erecting shop and crane runway girders of reinforced concrete construction, in our issue of Feb. 2 (p. 112), we omitted to state that the paper from which this description was taken was by Mr. C. C. Stowell, C. E., of Rockford, Ill.

REINFORCED CONCRETE ROUNDHOUSE FOR THE CANADIAN PACIFIC RY., AT MOOSE JAW, CANADA.

In describing, in our issue of April 14, 1904, the reinforced concrete roundhouse constructed for the Long Island R. R. at Morris Park, N. Y., reference was made to the previous use of this construction by the Canadian Pacific Ry. Through the courtesy of Mr. F. P. Gutelius, Engineer Maintenance of Way, we are able to give here some details of the Canadian Pacific construction as represented by the new roundhouse at Moose Jaw, Assiniboia. This construction, it may be noted, has been adopted as the standard construction for first class engine houses, by the Canadian Pacific engineers, so that the structure at Moose Jaw has a wider significance than if it were merely an isolated example.

The roundhouse at Moose Jaw is annular in plan and occupies half of a circle, the diameter of which is 350 ft. 5 ins. The radial width of the house is 80 ft., and it has 22 stalls divided into two groups of 11 stalls each by a radial fire wall. Each stall subtends an outside wall space of 25

ft. The end walls, fire wall and outside wall are of plain concrete, the latter being enlarged by buttresses or pires between stall spaces to carry the outer ends of the radial roof girders, which are further supported by an inside wall column and two intermediate columns. The combined

To construct the roof beams use was made of a form constructed as shown by the drawings of Fig. 5. This form consists of two trussed side pieces which are suspended from the main girders by means of yokes. The other details are clearly shown by the drawings.

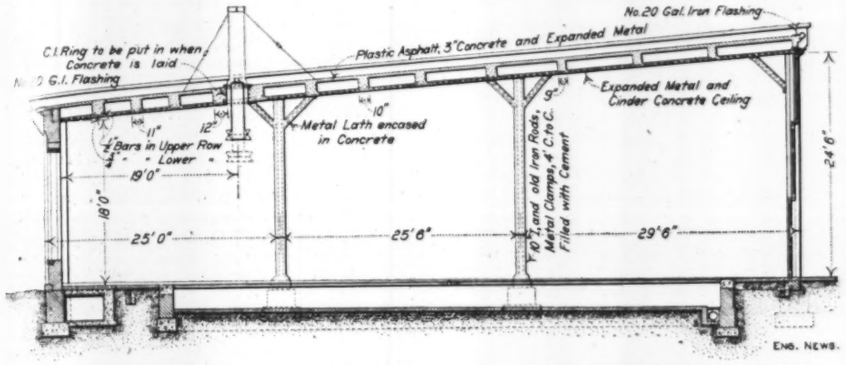
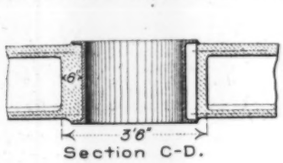


FIG. 1. TRANSVERSE SECTION THROUGH ENGINE PIT OF REINFORCED CONCRETE ROUNDHOUSE AT MOOSE JAW, ASSINIBOIA, CANADIAN PACIFIC RY.

roof, wall and column construction is made quite clear by the radial section, Fig. 1.

Briefly, each radial roof girder which is an 18-in., 55-lb. I-beam, is carried by an outside wall pier and three I-beam columns inclosed in concrete to form the section shown by Fig. 2. The space between main roof girders is spanned by reinforced concrete beams carrying a reinforced concrete roof slab and a suspended metal lath and plaster ceiling. The main girders and the angles which knee-brace them to the columns are, like the



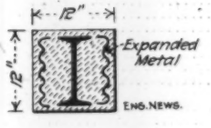


Fig. 2. Section of Column.

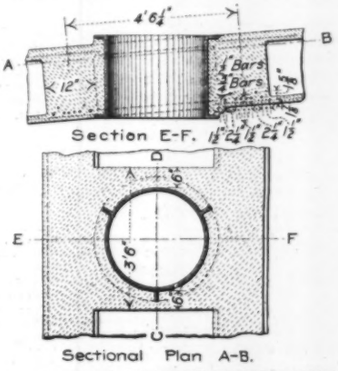


FIG. 4. DETAILS OF ROOF CONSTRUCTION AT SMOKE JACK OPENINGS.

columns, encased with concrete. There is, therefore, no unprotected structural metal in the roundhouse.

Turning now to the principal details, the encased I-beam column section is shown, as already stated, by Fig. 2. Fig. 3 shows the reinforced concrete beam, roof slab and ceiling construction. The beams are of uniform depth, but vary in width and amount of reinforcement, with the span. They are composed of 1-3-5 Portland cement gravel concrete. The roof slab is composed of cement and washed cinders, and the ceiling slab consists simply of expanded metal wired to the beams and given two coats of cement plaster, the first coat containing enough lime to make it work well under the trowel, and the second coat being a 1 cement 1 sand mortar. It will be noted that the beam reinforcement consists of plain round rods, the connection of which to the I-beam girders is shown by Fig. 3. Another point to be noted is that no joints have been provided in the roof to accommodate expansion and contraction. So far the roof, which has been built about a year, has shown no trouble from temperature or other movements.

At the points in the roof where the metal smoke jacks are located the beam and slab are reinforced, as shown by the drawings of Fig. 4, which are readily understood when considered in connection with Fig. 1.

Mr. Gutelius states that the cost of a building of this character varies as much as 25 per cent. in different localities. The house at Moose Jaw cost complete $3,000 per stall.

NOTES OF AN ENGINEER IN CHINA.

By W. E. Crane.

A majority of the foreigners one meets in China, when speaking of the Chinese, say that they do not understand them. It might reasonably be further stated that the Chinese do not understand themselves.

There are 18 provinces in China proper. Some provinces are closed territory, not only to the "Foreign Devil" but to the inhabitants of other provinces. There are eight or more different dialects and these are again subdivided into local dialects. The Pekinese or Mandarin is the official language spoken.

Omitting the dependencies of Manchuria, Mongolia and Tibet and the French Indo-China in the southwest, China proper is almost rectangular in shape.

The Americans have a concession for, and are building a railway from Canton to Hankow, and the Belgians have a concession for a railway from Hankow to Pekin upon which work is being done. This, with the American concession, forms a main line from Canton to Pekin almost centrally (east and west) through the length of China.

I visited Canton and went over a short section of the American railway, 30 miles of which has been completed and is in full operation. This is a branch line only, and is not the main line from Canton to Hankow, but about one mile of which has been constructed; but work is to go on immediately.

I am told that the line is proving very profitable, and there is no doubt but that the whole line when completed will be a paying investment.

The work of constructing railway lines in China has much to contend with. It will probably be a score of years before the main lines already planned will be completed, and it is very improbable that many branch lines will ever be constructed. There should be, however, a great local and through passenger traffic over the Canton, Hankow & Pekin R. R.

The delta of the Yang Tse is the center of the richest industries and the garden of the empire. For miles northwest and southwest of Shanghai a vast net work of rivers, creeks, canals, ditches and water-courses intersect the surface of the country. This tangled web of canals and water-courses is used for supplying water for irrigation purposes and as means of communication with different sections inland.

I took an interesting excursion in a house-boat with the editor of one of the English newspapers published in China, up the Whangpo River and one of its affluents to the ruins of Cho Lin, a walled city of 6,000 people, which was destroyed in the Taiping rebellion.

The creek up which our house-boat went from the main river to the city was a narrow, very crooked channel, 40 to 50 ft. wide, with banks on each side 10 to 20 ft. high. A series of side creeks and canals branched from this creek and intermediate between these were ditches 10 or 20 ft. in width, used as irrigating ditches and as means of communication with the hamlet or individual farm-house. As one party states it, "every barnyard is connected by ditch to the creek or canal, and the farmer loads his marketable products into boats at his door-yard and goes to market."

Over these water courses are foot bridges usually constructed of three spans of stone girders. The stones were usually 30 ft. in length, 18 ins. wide and 112 ins. deep. The two piers are usually the same sized stones set on end. Many of the bridges are of stone arch. The center of the bridge is usually higher than the shore ends, and usually several feet above the level of the surrounding country.

The people in this section are well to do. The farm houses are built of adobe brick sundried until they cease shrinking. Houses are usually narrow, of considerable length, sometimes divided into three rooms. There is usually a tile roof, and in most cases a quite large door yard surrounded with a bamboo fence.

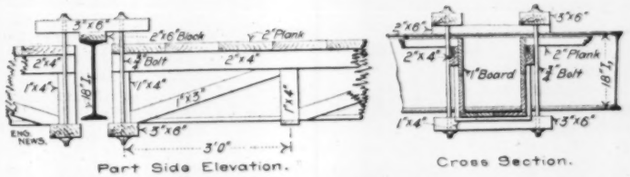


FIG. 5. FORMS FOR SLAB AND GIRDER ROOF CONSTRUCTION, MOOSE JAW ROUNDHOUSE.

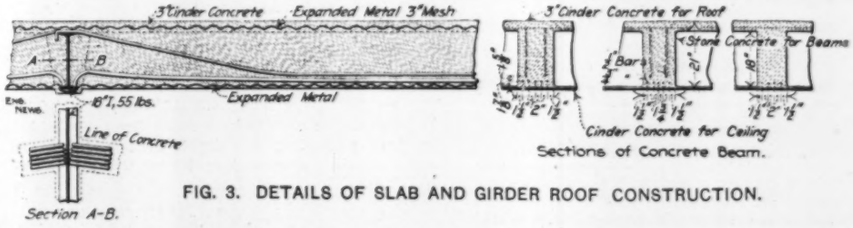


FIG. 3. DETAILS OF SLAB AND GIRDER ROOF CONSTRUCTION.

Groves of bamboo are planted around the home, and in many instances completely hide the house. These houses are comfortable and the surroundings and conditions are much better than similar conditions in the Balkan countries of Europe, Turkey in Asia, Egypt and even better than the conditions in parts of Texas, New Mexico and Arizona.

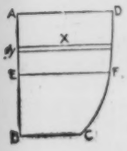
Since the creeks and waterways are the public highways of the country, it follows that in the construction of railways these highways are not to be disturbed, and the numerous waterway crossings will require drawbridges and attendants. The roadbed must be carried on a high grade over the waterways. This will make the construction costly.

THE PARABOLIC METHOD OF COMPUTING STREAM GAGINGS.

By F. W. Hanna.*

While teaching hydrography for a number of years the writer developed the following method of applying Simpson's one-third rule to the computation of stream gagings, both for open and frozen streams. The method is based upon the three following assumptions: (1) The cross-section of the bed of a river, when taken in a successive series of short arcs, very closely approximates sections of a parabola; (2) the curve of rates of flow of water in a vertical plane is sensibly a parabola whose axis is parallel to the surface, both for open and frozen streams; (3) the curve of the rates of flow of water in a horizontal plane is practically a parabola whose axis is parallel to the direction of the current. All three of the foregoing statements are classic hydrographic facts. They do not need further verification. The writer, however, has spent considerable time in numerous experiments and calculations in testing the accuracy of these principles and has found that the error of their assumption is in all instances negligible.

In applying the strictly parabolic method of computation it is necessary that the stream be sounded at equal successive intervals and that meter observations be taken at the surface, mid-depth, and bed of the stream at each place of sounding. In working up the notes it is necessary and convenient to find the mean depth and the mean velocity for a double section, then to compute the discharge for that section by taking the continued product of the width, mean depth and mean velocity. The general process, therefore, requires the mean abscissa of each of the foregoing parabolas. Formulae for determining these values are developed from the accompanying figure:



Let A D, E F, and B C lie equally distant and perpendicular to A B; also let D F C be the arc of a parabola having its axis parallel to A D. Now, by the Simpson one-third rule,† area

$$A\,B\,C\,D = \frac{A\,B}{6}(A\,D + 4\,E\,F + B\,C).$$

If this area be divided by the base, A B, of the figure, its mean altitude or abscissa is given by the expression,

$$\frac{A\,D + 4\,E\,F + B\,C}{6}.$$

This same value can be obtained by the theory of mean values from the expression,

$$\text{mean value of } X = \frac{\int x\,dy}{\int dy}.$$

The integration between the proper limits of this expression and reduction by the principles of the parabola give directly the value of the mean abscissa as above, but the process is quite long and is here omitted to economize space. Inasmuch as the Simpson one-third rule is independent of the convexity or concavity of the curve D F C to the line A B, the above work is perfectly general and may be applied to all cases desired in this discussion.

If a, b, and c be any three equally spaced successive soundings and D be the mean depth of the section bounded by the two extreme depths, then, since the bed of the stream is assumed to be a parabola,

$$(1)\quad D = \frac{a + 4\,b + c}{6}.$$

Again, if V_1, V_2 and V_3 be the respective top, mid-depth and bottom velocities in a vertical at any sounding point and V^1 be the mean velocity at that point, then since the vertical velocity curve is assumed to be a parabola,

$$(2)\quad V^1 = \frac{V_1 + 4\,V_2 + V_3}{6}.$$

Once more, if Va, Vb and Vc be the respective mean velocities at the points of sounding whose depths are respectively a, b and c, and V be the mean velocity of the section extending from sounding, a, to sounding, c, then, since the horizontal change in velocity is assumed to follow the law of the parabola,

$$(3)\quad V = \frac{Va + 4\,Vb + Vc}{6}.$$

Formulas 1, 2 and 3 having been applied to find, respectively, the mean depth, the mean velocity in the vertical plane, and the mean velocity in the horizontal plane for any double section, then the discharge of that section is obtained by taking the continued product of the width of the section, the mean depth, and the mean velocity as found by Formula 3. The total discharge of the stream is evidently the sum of the discharges of all the double sections including the incomplete section or sections at the bank or banks as the case may be.

Very often the conditions of the current at a gaging station or the time at the disposal of the engineer does not warrant an attempt to get the velocity at the top, mid-depth and bottom of the vertical. When the stream is frozen over or when for any reason vertical velocity curves would otherwise be used, this method is most practical and efficient; but, when the stream is open, and especially when it is in flood or from other cause has a high velocity, any of the common methods of getting the mean velocity with respect to the vertical may be more expeditiously employed. If the meter observations are made by integration or at 0.6 depth or by any method with such subsequent treatment as to obtain the mean velocity in the vertical, then there is no need for an application of Formula 2. The calculation would otherwise be identical with that outlined above.

The parabolic method, except Formula 2, is now used extensively by the United States Geological Survey. The claims for its advantages are adaptability to systematic note-keeping, all elements of the discharge being recorded separately; ease of application, being simple in form; and accuracy in results, being based on the parabolic theory of change of bed and velocity of stream from point to point instead of on the usual rectilinear assumptions.

Any scientific system of keeping engineering notes, and especially current meter notes, should provide for an entry of every item of observation and calculation. The proper plan for working up notes by the above method, therefore, necessitates a series of 16 columns crossed by horizontal lines. These columns, in order, should contain: (1) The distance of the meter observation from the initial point of sounding; (2) depth of sounding; (3) depth of meter observation; (4) time of meter observation; (5) count of meter revolutions; (6) a check count of the same; (7) sum of the two meter revolution counts; (8) number of meter revolutions per second; (9) observed velocity of flow per second; (10) mean velocity in a vertical plane (as found by Formula 2, or by any means where that velocity is not assumed to be directly observed, in which case the column would be left blank); (11) mean velocity in a horizontal plane (as found by Formula 3, which applies to a section having twice the width between meter and sounding observations); (12) width of the above section; (13) mean depth of that section (as found by Formula 1); (14) area of that section; (15) discharge of the same; (16) remarks of various points in observation and calculation.

The incomplete sections at the banks, piers, etc., should be subjected to the trapezoidal rule for obtaining mean depth and mean velocity in the horizontal plane, the notes being carried across the page in the same manner as for complete sections. The sum of Columns 12, 14 and 15 evidently give, respectively, the total width, the total area and the total discharge.

*Assistant Engineer, U. S. Geological Survey, Washington, D. C.

†A demonstration of Simpson's one-third rule may be found in any large work of importance on integral calculus.

NOTES FROM THE ENGINEERING SCHOOLS.

HARVARD UNIVERSITY.—The annual report of President Charles W. Eliot, of Harvard University, contains interesting data relative to the Division of Engineering. Prof. Hollis says:

"The raising of the requirements for entrance to the Scientific School, and the possibility of obtaining in five years the academic and scientific degrees have served to induce many students of engineering to spend three years in the college before entering the Scientific School. The consequence has been a very marked increase in elections of engineering courses by college students. [The percentage of engineering graduates who hold the degree of A. B., has increased in three years from 11% to 36%.—Ed.] This tendency is in the right direction, and should, if encouraged, build up a graduate professional school, analogous to the Law School.

Speaking of the summer camp at Squam Lake, Prof. Hollis says:

It should be the place where a student may go to take only one subject at a time, thus concentrating his efforts upon the attainment of one end.

This plan has worked admirably in the surveying courses, which are well adapted to camp life, and the results afford valuable evidence for other courses. During the past summer students were taken in descriptive geometry, graphical statics, resistance of materials, and applied mechanics, to the number of 51 enrollments. For their benefit the day was divided into two periods, and it was found easily possible to hold their attention to a single subject for six or eight hours without fatigue. The woods and lake afford healthful relaxation, free from the distractions of Cambridge and Boston. Judging from the experience of the summer, it seems possible for a student to work at in-door studies for ten weeks in the country without losing his vigor for the fall term. The vacation habit is bad when it means three months of idleness every year, and it would seem worth while for the University to try seriously the experiment of putting other subjects besides those pertaining to engineering into the summer camp for college students. At present few courses given in Cambridge under the auspices of the Summer School count for the degrees, but the summer work at Squam Lake is intended almost wholly for Harvard students.

The following table shows the occupations of the fathers of students enrolled in the College and the Lawrence Scientific School in the summer and autumn of 1904:

Occupation.	College.	Scientific School.
Business	43.1%	62.1%
Professional	25.5%	13.3%
Wage earners	12.6%	11.3%
Government officials	2.6%	1.1%
Farmers	2.6%	3.0%
No record	10.8%	9.2%
No occupation	2.8%	0.0%
Total	100.0%	100.0%
Total number	2,009	530

The great majority of the students come from cities and towns; and the exceedingly small percentage of those who have come from the farms is noteworthy in comparison with many of our Western engineering schools.

TOO MANY APPLICANTS FOR THE PANAMA CANAL service are reported by the U. S. Civil Service Commission. It announces that the number of applicants for clerical and professional positions in that service, including clerk, bookkeeper, timekeeper, surgeon, physician, pharmacist, hospital interne, trained nurse, assistant civil engineer, instrumentman, transitman, levelman, rodman and chainman, is far in excess of the needs of the service, and it is not expected that any more examinations of this kind will be held in the near future. No more applications will be accepted for these positions at this time, and no further information will be furnished in regard to them. On the other hand, competent and experienced persons are especially desired for positions as members of steam shovel crews, particularly crane men and pit foremen.

A 500-VOLT UNIPOLAR DYNAMO has been built at the shops of the General Electric Co., Schenectady, N. Y. The machine is mounted over a 500-HP. Curtis steam turbine, to which it is direct-connected. The field magnet structure, of solid steel casting, has two magnetic circuits. It forms three rings around the armature, the middle one taking flux from both circuits; the armature conductors lie only under the middle pole-ring. Two circular coils furnish the excitation. Between the middle and the two lateral pole-rings the field-structure has several openings; through these the conductors leading from brushes on the collector-rings are carried out and joined to those of the opposite side outside of the frame. The armature is

also a solid steel casting. The conductors are straight bars, each leading to a collector-ring at each end. Twelve conductors are on the armature, and they are all connected in series by the brushes and the outside connectors. The machine runs at a peripheral speed of 12,000 to 15,000 ft. per min. The collector-rings are steel castings, and the brushes are copper. Their contact-resistance, when the machine is running, is found to be very high at low current values and much lower at high output; when the machine it at rest, on the other hand, the contact resistance is constant. The efficiency of this machine is 91% at full load and 88% at half load. Its regulation is 6 to 12%, depending on the excitation and on the position of the brushes. It is found that the machine may be compounded by carrying the ends of the conductors backward at an angle before joining them to the collector-rings. The machine may even be made self-exciting by this method. This dynamo, the first large unipolar machine ever built, has about the same size and weight as an equivalent machine of the commutator type, but due to its much simpler construction it should cost less to build in sizes of 300 KW. or over; in smaller sizes it shows no such advantage, as the limiting influence of armature speed requires a relatively larger machine. The machine was briefly described in a paper read recently before the American Institute of Electrical Engineers by Mr. J. E. Noeggerath, who gave also a discussion of the principal factors of design.

AN ELECTRIC RACK RAILWAY to the summit of Mont Blanc has just been put under construction. The line extends from Le Fayet, on the Paris, Lyons & Mediterranean Ry., to the summit of Mont Blanc, and on the first section, extending to the Aiguille du Gôuter, 12,590 ft. above sea level, work has been commenced. The starting point, Le Fayet, is 1,902 ft. above the sea level, and 11¼ miles from the summit by the route followed, which is mostly in the open, with four tunnels of 853 ft., 1,279 ft., 820 ft., and 7,316 ft. long, respectively, at the upper end. The total difference in height is 10,630 ft., the gradients of the line varying from 92 to 232 ft. per mile. The gage of the line is 1 m., the minimum radius of curvature 50 m.—164 ft. The rails weigh 42 lbs. to the yard, each length of 34.5 ft. is carried on twelve iron cross sleepers, and the rack rails are similar to those on the Jungfrau line. The tunnels are horseshoe shaped in section, with a breadth of 11½ ft. at the bottom, and 13 ft. 1½ ins. at the broadest part of the arch, the heights varying between 11½ ft. and 12½ ft. The carriages, to be 9½ ft. high above the top edge of the rails, and 8.2 ft. wide, will be run in trains of three, consisting of a 14-ton motor car and two 4-ton trailers, with a total carrying capacity of 80 passengers. From ten to twelve trains will be run daily. From the terminus of the line as at present conceded, a further length of tunnel of about 2½ miles will be required to reach the summit of Mont Blanc, which is 15,780 ft. above sea level, or nearly 3,000 ft. higher than the Aiguille du Gôuter.

EFFICIENCIES OF MOTOR-DRIVEN PUMPS for supplying hydraulic elevators may be very high, according to a statement of Mr. Thos. E. Brown in a paper on "Passenger Elevators," read before the International Engineering Congress. Tests made by Mr. Brown on Quimby screw pumps at Newark, N. J., operating with 500-volt current against a water-pressure of 105 lbs. per sq. in., showed an efficiency of 63% from wire to water. A three-throw motor-driven belted pump in Chicago, Ill., operating against a water-pressure of 735 lbs. per sq. in., showed an efficiency of 82% from wire to water.

AN EFFICIENCY TEST OF SPUR GEARS, used rough as cast, is reported in the "American Machinist" of Jan. 12, 1905. The test, made by Mr. W. M. Wilson, covered two pairs of gears, both of 1½-in. circular pitch. The test arrangement was very simple: A wooden frame carried the two shafts on which were fixed the gears, and the two bearings of each shaft were held to the frame by clamps so that the center-to-center distance could be varied. One of the shafts was belted from an electric motor, and a Prony brake was arranged to be fastened to either shaft; this brake was first mounted on the driver-gear shaft, the gears being out of mesh, and by measuring its power absorption at the same time as voltage and current of the motor, a set of calibration curves could be drawn, giving the power delivered by the driver-gear shaft for any given current and voltage. By then bringing into mesh the pair of gears to be tested, and transferring the Prony brake to the driven-gear shaft, the output from the latter shaft was measured. Since the output of the driver-gear shaft was obtainable from the motor readings, the efficiency of the driver-gear shaft as a whole was given by simple division. This efficiency is composed of the efficiency of two shaft-bearings and the actual gear efficiency. The journal friction was approximated by taking its coefficient of friction at 0.03, combining the theoretical gear thrust and pressure with the weights acting, and computing the friction loss for any given speed. The two pairs of gears tested were (1) 20 teeth—20 teeth unknown shape, and (2) 16 teeth—50 teeth involute, both sets being of 1½-in. circumferential pitch. The former pair was tried at five speeds, two speeds with gears dry and three speeds with gears greased; the latter pair was tested at three speeds, lubricated. The results show an extreme variation, both sets inclusive, from 86.8% to 97.8%, these figures being the combined efficiency of the gearing and the driven-gear journals. The averages, for each set, range from 89.6% to 96.3%, again including the bearing friction. The results do not permit of definite conclusions as to effect of speed and contact pressure, but they suggest that variations of 2 to 3% may be produced by each of these factors. The speeds used were from 56 to 240 r. p. m. Eliminating the bearing friction loss would, it was calculated, raise all the efficiencies noted by about 1½ to 2%.

A PECULIAR RAILWAY ACCIDENT occurred on the New York Central & Hudson River R. R. near Utica, N. Y., on Feb. 4. The locomotive boiler of a westbound express train exploded just as it was passing an eastbound passenger train on the other track. Both trains were derailed and several cars were badly wrecked. The engine crew of the wrecked engine was killed and several passengers of the other train were injured.

A FLYWHEEL BURST at the electric generating station of the Shreveport Gas, Electric Light & Power Co., Shreveport, La., on Jan. 30, killing one man. The wheel was 18 ft. in diameter by 4 ft. face.

THE NEW WATER SUPPLY FOR SPRINGFIELD, Mass., as proposed by a special commission in three reports made in 1904, has been disapproved by the State Board of Health. The scheme called for a slow sand filtration plant working at the rate of 5,000,000 gallons an acre a day; a large storage reservoir on Axe Factory Brook, connected by a canal with Jabish and Broad brooks and a pipe-line from the reservoir to the filters or to the present Ludlow reservoir. Under this plan water from the Ludlow reservoir would be used whenever the anabaena in it were not so numerous as to render single filtration impracticable and water from the new reservoir the remainder of the time, this also to be filtered. The State Board of Health believes that this plan is inadequate as to quantity, of unproved efficiency as to quality and that its cost would exceed the estimates made by the special commission. It suggests as worthy of consideration as possible sources of supply the east and middle branches of the Westfield River and also the Westfield Little River. It advises a thorough investigation and report "of the various sources which now appear to be available," to be made "with the assistance of an engineer of experience in matters relating to water supply," and to be sufficiently exhaustive to serve as a basis for estimating cost and judging of the yield and quality of the water.

THE OPERATION OF BULKHEAD DOORS by power and from a central station is provided for in the new U. S. Armored Cruisers "Colorado" and "Pennsylvania," and has, it is stated, been specified for all other war vessels now under construction for the U. S. Navy. As described, the system consists of (1) An emergency station, located usually in the pilot house or some convenient place above the deck. (2) The power-doors or hatch-gears, supplied with three independent mechanisms: (a) The switch by which a man at any door can open and close it at will from either side. (b) The switch, operated from the emergency station, by which the door is closed upon the approach of danger. This emergency switch, although permitting absolute control, may have its operation suspended temporarily by the hand switch just mentioned. In such a case the emergency station switch will close the door as soon as the hand controller is released. (c) The limit switch, by means of which the current supplying the motor which provides the power for closing and opening the doors, is cut off when the door has closed and locked, or has encountered an obstacle to full closure. This switch has mechanical connection with the door or hatch-plate and is so arranged that it will cut off the current from the motor, and thus prevent blowing out of the fuses. An interesting improvement of this part of the mechanism is one by which the switch is made to again close the circuit to the motor and thus start the door toward its grooves after an obstruction is removed, e. g., when an inflow of water washes away coal obstructing a bunker opening.

STEAM SUPERHEATING APPARATUS IN EUROPE was the subject of a consular inquiry whose results are made public in a recent bulletin of Consular Reports. The purpose of the inquiry was to gather the various regulations and restrictions concerning superheaters promulgated in European countries. The results, very briefly summarized, are the following:

AUSTRIA.—No regulations concerning superheaters. The decrees and orders referring to steam apparatus are insufficient or obsolescent, and in some instances contradictory. Cast-iron is not barred for parts not exposed to flame.

GERMANY.—Superheaters come under the general imperial boiler regulations as regards approval by the official inspector after test, and compliance with building, fire and sanitary police regulations. Special clauses governing superheaters in the Kingdom of Prussia are:

It must be possible to shut off at will the gases of combustion from the superheating device, even when it is located in one of the flues of the boiler. It must be possible to shut off the steam supply from the superheater. When it is to be feared that condensed water may collect in a superheater thus cut out of action, the evaporation of which may produce dangerous tension when the superheater is again brought into operation, the superheater must be provided with a steam safety valve and at its lowest part with a drain valve. All devices for controlling the superheater must, so far as practicable, be within reach of the fireman. Cast-iron is not barred, provided that it meets these requirements, and there exist no special regulations concerning superheaters in which cast iron is used.

No special regulations exist in Bavaria. In Saxony the use of cast iron is prohibited in all boiler parts exposed to flame, and in any case requires the discretionary approval of the authorities.

ITALY.—No regulations regarding superheaters for marine use. For boilers in use on land, a law of 1888 prohibits the use of cast-iron and sheet copper for parts exposed to fire, except that copper tubes may be used up to 3.9 ins. in diameter. Cast metal is permitted in steam domes, boiler heads, manhole covers, mud collectors, economizers and similar apparatus such as is not enclosed in the setting and not exposed to direct flame and of diameter not over 27.6 ins. The rules apply less rigidly to boilers of special character such as may be designated by law; in this class are the multitubular inexplosible boilers of Belleville, Field, Babcock & Wilcox, Steinmueller, etc.

SWEDEN.—No regulations regarding steam superheating apparatus exist. Cast-iron in boilers should be given a safety factor of ten.

NORWAY.—No regulations.

GREAT BRITAIN.—No regulations, except those for boilers generally in the Factory and Workshop Act, and the Boiler Explosions Acts. Cast-iron and copper are not considered suitable materials for superheaters, except that headers, covers, etc., not exposed to flame are often made of cast iron.

THE LIERNUR PNEUMATIC SEWERAGE SYSTEM IS used to collect the sewage of eleven municipalities and industrial establishments, serving a total of about 230,000 people, 200,000 of whom are in Amsterdam and 12,000 in Trouville, France. The first and thus far the only plant in an English-speaking country was installed at Stanstead, Essex, England, some two years ago. The plant was put in under an agreement that the proprietors of the system should build and operate it for two years at its own cost. At the expiration of the two years the company was to remove the plant if unsatisfactory, while if satisfactory the municipal authorities were to apply to the Local Government Board for a loan with which to buy the plant. It is expected that the application for a loan will be made in January, 1905. The Liernur improved system, as it is now called, is adapted for use on full-water carriage systems as well as for the removal of excreta alone, but as employed on water-carriage systems the amount of water entering the pipe system is relatively small. In fact, the small quantity of flushing water permisible is one of the great advantages claimed for the system abroad. As some of our readers will remember, the Liernur system brings excreta or sewage, as the case may be, to a central station by means of a partial vacuum produced in a main sewer, district reservoirs and house connections. For the information given we are indebted to Mr. Fred. A. Donne, Secretary of Liernur's English Syndicate, 110 Cannon St., London, E. C., England.

PERSONAL.

Mr. James Walker and Mr. M. M. Green have opened a consulting engineering office at 500 Union Trust Building, Detroit, Mich.

Mr. C. J. Field is no longer in the conduit business and is not now actively connected with the Field-Foulks Co., of 29 Broadway, New York.

Mr. Luther B. Martin has been appointed Superintendent of the Water Department of East Orange, N. J., to succeed Mr. Lorton McDermott.

Mr. E. G. Lane has been appointed Division Engineer of the Baltimore & Ohio R. R., at New Castle, Pa., to succeed Mr. J. B. Cameron, resigned.

Mr. W. North Robin is now Director of the Engineering Employment Bureau of Syracuse, N. Y., the control of that concern having been transferred to him.

Mr. F. B. McCutcheon has been appointed Chief Engineer of the Gulf & Ship Island Ry., with headquarters at Gulfport, Miss., to succeed Mr. W. W. Vail, resigned.

Prof. F. A. Fish, of the Ohio State University, has been selected by the trustees of the Iowa State College, Ames, Ia., to succeed the late Prof. B. S. Lanphear in the Electrical Engineering Department.

Mr. Henry E. Funk has been appointed Superintendent of the Lexington Hydraulic & Manufacturing Co., of Lexington, Ky., to succeed Mr. S. A. Charles, whose re-

tirement from that position was noted in our issue of last week.

Mr. George Wagstaff has been appointed Supervisor of Boilers of New York Central & Hudson River R. R. Co., and its leased lines, and will have his headquarters at Buffalo, N. Y. He will report to F. M. Whyte, General Mechanical Engineer.

Major Villiers Sankey has resigned the position of City Surveyor of Toronto, Ont., to accept a position on the engineering staff of the Grand Trunk Pacific Ry. He will have charge of exploration work in the district between Winnipeg and Lake Nepigon.

Mr. R. E. Gaut, Assistant Engineer of Bridges has been appointed Engineer of Bridges of the Illinois Central R. R., to succeed Mr. F. H. Bainbridge, who recently resigned to go to the Chicago & Northwestern R. R. Mr. H. H. Hadsall succeeds Mr. Gaut.

Mr. C. A. Colburn, of Germantown, Pa., a civil engineer in the employ of the Philadelphia & Reading R. R., was seriously injured Feb. 2, by being struck by a construction train. Several ribs were broken. He was taken to St. Francis Hospital, Trenton, N. J.

Mr. R. B. Williamson, for the past five and a half years in charge of the Electrical Engineering Department of the International Correspondence Schools, Scranton, Pa., has resigned to accept a position on the engineering staff of the Bullock Electric Manufacturing Co. Mr. Williamson will be located at Cincinnati, O.

Mr. E. L. Byron, for the past 20 years connected with The Vulcam Iron Works Co., has been promoted to the position of General Manager. This does not mean that Mr. Alexander Backus will retire from that place, but that Mr. Byron will take much of the responsibility that has hitherto rested on the shoulders of Mr. Backus.

Mr. Wm M. Jewell, for the past 15 years with the O. H. Jewell Filter Co. and the New York Continental Jewell Filtration Co., will henceforth devote his entire time to his practice as chemical and consulting engineer. He will give especial attention to water supplies, filtration plants, and as expert in patent cases. His offices are in the Cable Building, Chicago, Ill.

Mr. F. B. Maltby, M. Am. Soc. C. E., has been appointed Division Engineer under the Isthmian Canal Commission and will have charge of the dredging operations. For the past three years Mr. Maltby has been engaged as Superintendent of dredging operations in charge of the hydraulic dredges on the Mississippi River, under the Mississippi River Commission.

Mr. I. M de Varona, M. Am. Soc. C. E. Chief Engineer Department of Water Supply, Gas and Electricity of the Borough of Brooklyn, has been appointed Acting Chief Engineer of the Department of Water Supply of New York city. Mr. de Varona assumed his new duties Feb. 1, but will retain his former position as Chief Engineer of the Department of the Borough of Brooklyn.

Major Hugh J. Gallagher, General Staff, U. S. A., who was detailed by direction of the President for service with the Isthmian Canal Commission, has assumed the duties of Purchasing Agent of the Commission, with headquarters at their Washington office. Major Gallagher has had wide experience in purchasing supplies for the Army and is regarded at the War Department as one of the best informed and most efficient purchasing agents in the country.

Mr. Henry B. Ledyard, who recently resigned the Presidency of the Michigan Central R. R. and became Chairman of the Executive Board, began his railroad career in 1870, when he joined the engineering force of the Northern Pacific R. R. He became Division Superintendent of the Michigan Central R. R. in 1874, Assistant General Superintendent in 1876, General Superintendent in 1877, General Manager in 1878, and in 1888 he was elected President, a position he held until his resignation on Jan. 31, 1905.

Mr. E. P. Osgood, of the Royal Sanitary Department at Bangkok, Siam, has been appointed as the European on the Commission which left Bangkok Dec. 30 for Saigon, to take up the work of the delimitation of the boundary between French Indo-China and Siam, in accordance with the convention ratified last November between France and Siam. The present work is the delimitation from the Inland Sea to the town of Krat, which town is to be ceded to France. The Commission is composed of two Siamese and Mr. Osgood, and the survey work is in charge of Mr. Lowe, an Englishman.

Mr. Charles E. Wells, M. Am. Soc. C. E., has been appointed Constructing Engineer in the U. S. Reclamation Service, in charge of the Pathfinder dam in Wyoming. Mr. Wells reported for duty on the 8th of February and will establish temporary headquarters in Denver, Colo., pending the letting of contracts for building the dam and other structures. Mr. Wells has been appointed from the Civil Service from a large list of engineers who took the examination in April, 1904. He is a graduate of the Worcester Polytechnic Institute and since 1880 has been actively engaged in his profession. His last work previous to joining the Reclamation Service was on the Wachusetts dam at Clinton, Mass., where he served as Engineer of the Reservoir Department of the Metropolitan Water-Works.

Obituary.

Charles H. Cady, a metallurgist and iron mining expert died Jan. 28 at his home in Ballston, N. Y., aged 65 years.

D. W. Thomas, the architect who built the Baltimore Court House and other public edifices in Baltimore, Md., died Jan. 31 in that city.

W. J. Howard, a retired mining engineer, died Feb. 1, at his home in Denver, Colo. Mr. Howard had returned recently from South Africa, where he had been employed by an English company.

Harrison H. Taylor, inventor of a water tube marine boiler that has been adopted by the U. S. Government, and a number of useful mechanical appliances, died Feb. 3 at his home in Detroit, Mich.

Col. Philip Eastwick of Portland, Ore., died of yellow fever Feb. 2, at Panama, where he had gone to visit his son. Colonel Eastwick was a civil engineer and had had charge of many government works on the Pacific Coast.

Charles E. Dickey, founder of the American Meter Co., committed suicide Feb. 4 at his home in Baltimore, Md., by shooting himself in the head. He was 73 years old and for some time had been afflicted with diabetes.

R. H. Barrett, a civil engineer in the employ of the Grand Trunk Pacific Ry., was killed Jan. 29 at Toronto, Ont., by a fall from the window of the lodging house at which he was stopping. He was a graduate of the School of Practical Science of Toronto University, and was about 30 years old.

Alexander McGaw, Architect and Engineer, died Jan. 30 at his home in Philadelphia, Pa., aged 77 years. Mr. McGaw built the pedestal for the Statue of Liberty and also constructed the New York Central Railroad bridge over the Harlem River, the drydock at Cramp's shipyard, the Girard Ave. bridge in Philadelphia, and numerous other bridges in different parts of this country and Canada.

Ludwig von Tetmajer, President of the International Association for Testing Materials, a prominent authority in the field of material-testing, died a few days ago at Vienna, Austria. Professor Tetmajer was a Hungarian by birth and received his education at Prague, at the Budapest Technical College, and at Vienna. He first engaged in railway work in Austria and later on the Swiss railways. When the Mount Pilatus rack railway was to be built he became assistant engineer, and as such prepared the specifications for the material. The requirements he set for the rail steel were at first considerd impossible, but by persistence and energy he secured the production of rails in conformity with his specification; he also devised means for cutting the racks in the rails, considered a difficult problem. Some of the original rails put into the Pilatus line are still in service. After another period of railway service Tetmajer was called to Zürich as professor at the Polytechnikum, and he remained there until about five years ago, when he went to the Vienna Technical College as head of the mechanical laboratory there. Both at Zürich and at Vienna Professor Tetmajer built up the material-testing course and developed a laboratory of first rank. With Bauschinger and Martens he was active in founding the International Association of Testing Materials, of which he became secretary. After Bauschinger's death, about eight years ago, he was chosen as his successor in the presidency, which position he has retained until his death. Professor Tetmajer's work in material-testing has been of highest grade and of great range. His influence was especially active in the formulation of methods of cement testing and the investigation of the properties of cement. He will also be remembered for numerous important theoretical and experimental researches in the field of properties of iron and steel.

ENGINEERING SOCIETIES.

COMING MEETINGS.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb. 14 and 15, 1905. Annual meeting at New Haven, Conn. Secy., J. Frederick Jackson, New Haven.

ASSOCIATION OF ONTARIO LAND SURVEYORS.
Feb. 28, 1905. Annual meeting at Toronto, Ont. Secy., Killaly Gamble, Temple Bldg., Toronto.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.
March 21, 22, 23. Annual meeting at Chicago. Secy., L. C. Fritch, 1562 Monadnock Block, Chicago.

AMERICAN ELECTROCHEMICAL SOCIETY.
April 25 to 27. Annual meeting at Boston and Cambridge, Mass. Secy., S. S. Sadtler, 39 S. 10th St., Philadelphia, Pa.

AMERICAN WATER-WORKS ASSOCIATION.—The secretary's address, after Feb. 15, 1905, will be J. M. Diven, c/o Light and Water Co., George St., Charleston, S. C.

AMERICAN INSTITUTE OF MINING ENGINEERS.—On Jan. 10, 1905, the American Institute of Mining Engineers was incorporated in New York State, its stated purpose being to promote the arts and sciences connected with the economic production of the useful minerals and the welfare of those employed in these industries.

WESTERN SOCIETY OF ENGINEERS.—At the meeting at the society's rooms in Chicago on Feb. 1, a paper was presented by Mr. A. Bement on "The Necessity for a Geological Survey of Illinois." The author suggested that the work should be done under the general direction of the U. S. Geological Survey. As a matter of fact the survey has more than once made a proposition to do such work on terms similar to those made with other States, but these propositions have never been accepted, the necessary bills authorizing the cooperation and expenditures not having been passed by the Illinois legislature. A suggestion was made in the discussion that the work should be undertaken by the University of Illinois, but this has the objection of lacking uniformity with the work of other States where the work has been done under the direction of the U. S. Geological Survey.

MONTANA SOCIETY OF ENGINEERS.—The eighteenth annual meeting of the Montana Society of Engineers was held in Butte on Friday and Saturday, Jan. 13 and 14, 1905, with the largest attendance of members within the history of the Society. Friday was devoted to visits to various points of interest about this mining region: the plant of the Montana Zinc Co. at Walkerville, the West Stewart mine, and the Pittsmont Smelter. Saturday was devoted to business, two meetings being held. Officers for the coming year were elected as follows: Ernest W. King, President; Bertram H. Dunshee, and Edward C. Kinney, Vice presidents; Clinton H. Moore, Secretary and Librarian; Samuel Barker, Jr., Treasurer; Robert A. McArthur, Trustee. After a lengthy discussion it was voted that the question of the Society remaining in the Association of Engineering Societies be made a special order of business at the March meeting and the Secretary be directed to invite written discussions from all active members of the Society. Technical papers were read as follows: President's address by Mr. I. E. Moultrop; "The Central & Cerro de Pasco Ry. of Peru," by Mr. E. J. Strasburger; "Sulphate of Copper As a Water Purifier," by Messrs. Starz and Carroll; "Stresses in a Gallows Frame," by Prof. C. H. Bowman; "U. S. Mining Laws," by C. W. Goodale. In the evening a banquet at the Hotel Finlen closed the meeting.

ENGINEERS' CLUB OF PHILADELPHIA.—The meeting on Saturday evening, Feb. 4, was held in a commodious auditorium instead of the rooms of the club in order to seat the large numbers who wished to hear the paper on the construction of and leaks in the Torresdale tunnel conduit, by Mr. John W. Hill, M. Am. Soc. C. E., Chief Engineer of the Philadelphia Bureau of Filtration. Mr. Hill described the construction of the tunnel (see Eng. News, Dec. 1, 1904), the nature and extent of the leaks that developed after its completion and the means taken to repair them. Some seventy-five lantern slides were used to illustrate the paper. The leaks, the speaker said, occurred chiefly at one or two of the sumps used in constructing the tunnel, at a hole or two found in the invert of the tunnel, at weep-holes that had not been closed and at some of the joints in the brickwork. The unfilled tunnel is under a head of 103 ft. In making repairs cast-iron chambers were inserted at the old sumps and filled with concrete and closed with grout and wood gaskets. Grout was pumped in through the remaining weep-holes and wedges of wood were driven into the leaking joints. Carefully designed and built weirs were used to measure the leakage into the several sections of the unfilled tunnel. The total leakage was compared with that in various other conduits, masonry, wood and cast-iron. These comparisons showed, the author said, only a moderate amount of leakage at Philadelphia. When the tunnel is in use leakage will be reversed and filtered water will be lost. Estimates of the additional cost of making the tunnel absolutely water tight, Mr. Hill stated, showed that the outlay would be far in excess of the value of the water saved. In commenting on the closeness with which most of the tunnel headings met Mr. Hill stated that not an assistant engineer on the tunnel had had any previous experience with tunnel work.

PACIFIC COAST RAILWAY CLUB.—At the January meeting of the club, held at San Francisco, Cal., on Jan. 21, Mr. R. M. Doble, of San Francisco, read a paper on "The Use of Pacific Coast Water Powers in the Electrical Operation of Railways." The paper first presented the advantages of electric operation; the cleanliness, better ventilation and lighting, the higher acceleration, the possibility of concentrating more power in one train, the saving in crew wages and cost of maintenance, etc. With the great distribution of water power in California, allowing many generating plants to be tied together in one network, the reliability factor of electric operation should be very high, the more so as an electric train is not disabled by the break-down of a single motor or single car. Recent steam and electric locomotives were described by the author, with the aid of lantern slide views and drawings. Electric traction on the Key Route and North Shore railways near San Francisco was described, and special stress laid on the advantages of multiple-unit operation. Polyphase and single-phase traction was also discussed. In conclusion some of the largest water power plants of California were briefly described, among them the new De Sabla power house of the California Gas & Electric Corporation, where an 8,000-HP. tangential water wheel, the largest single water wheel ever built, is in operation. This station regularly supplies power to San Francisco and other points over 300 miles from the station.